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Contents.

	PAGE
Forthcoming Events	257
Foundry Consciousness	257
The Vogue of the Industrial Efficiency Expert	257
Correspondence	258
French Foundrymen's Association	258
Random Shots	258
High-Test Cast Iron	259
The Kaiser-William Institute for Iron Research at Düsseldorf	261
The Light-Castings Industry	262
The Bnyer's Boomerang	262
The Effect of Moulding Methods on Estimating	262
Oil-Sand Cores in the Small Jobbing Foundry	263
The Photomicrography and Metallography of Graphite Flakes	265
Modern Industrial Management	267
Trade Improvement in Derby	269
Electricity as a Factor in Foundry Developments	270
Contracts Open	270
Trade Talk	272
Company News	272
Personal	272
Applications for Trade Marks	272
Reports and Dividends	272
Obituary	272
Iron and Steel Markets	274
Students' Corner	274

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

OCTOBER 19.

Lancashire Branch (Burnley Section):—First meeting of the session at Accrington. W. H. Poole will read a Paper on "The Cupola."

Wales and Monmouth Branch:—Ordinary meeting at Newport. "Coal-Dust," Lecture by Ben Hird.

West Riding of Yorkshire Branch:—Visit to Messrs. E. Green & Sons, Limited, of Wakefield, also Lecture on "Some Notes on the Condition and Effects of Graphite on Cast Iron," by H. R. Pitt.

Foundry Consciousness.

There are a great many large engineering firms at the present time engaged in the manufacture of a given article from start to finish, and such firms necessarily and invariably either make castings themselves or purchase castings as a subsidiary service. Making or purchasing in this way, no more attention is commonly paid to the matter than is paid to any other such subsidiary service—the purchasing of paint, for example. Yet in most cases cast iron represents a bigger proportion of the total weight of the finished product than any other material employed. We are repeatedly reminded, however, that the strength of a chain is to be measured by its weakest link, and cast iron is more than a single link in the chain of such a finished product. From this it follows that such indifference to the cast iron used—indifference especially to its quality—must represent a very considerable lowering of the potential quality of the finished product. Surely it would be an excellent thing for the health of the engineering industry in this country if our engineers were to stop for a moment and reflect that they are, or should be, founders no less than engineers. The fault lies, as a rule, with the people at the top, the big men who are necessarily preoccupied with wider issues, with questions of finance, of policy and of organisation. We would be the last to suggest or to expect that such men should turn their attention to matters of foundry detail; there are all too few men in England to-day who are able to cope with the wider issues in question, and if in that direction lies their ability then it would be the height of folly to distract it. But if this action is not required of them, other and suitable action is still within their power. These men are, as a rule, engineers either by training or by early experience or by both. They are, therefore, able to appreciate the character and significance of the engineering problems and difficulties that arise, and they are prepared to provide the staff and to afford the means and the facilities necessary to meet these problems and overcome these difficulties. But they are only very rarely so trained as to appreciate foundry problems and difficulties in the same way. Therefore it becomes increasingly important that they should recognise the significant part that cast iron plays in their product and the important part the founding process plays in the character and the quality of cast iron. When they have done this they will begin to realise the need to give as much attention to their foundries as they give to their engineering shops, instead of considering them as a subordinate part of the organisation and frequently ignoring them altogether. Bearing in mind how large a proportion of founding is done in and for the engineering works, this question becomes one of vital importance if the foundry trade is to make any real and united advance.

The Vogue of the Industrial Efficiency Expert.

Recently we seem to have encountered an exceptionally large amount of propaganda for various industrio-psychological activities, such as Safety-First, vocational suitability, education for foremanship, influence of rest-pauses on human effort and the like. In their earlier stages we found a real fascination in the efforts which were being made to correlate mental make-up and some branch of industrial activity, now they merely bore us. It is high time that it was recognised that once the underlying principles are widely known, their application is solely for the individual employer, manager or foreman. Recent researches, reports and propaganda have not materially advanced any of the phases indicated.

We recently received for review a pamphlet entitled "Report on Education for Foremanship," and it is typical of a large amount of matter which daily passes through our hands. In this case four prominent business men have been asked to state the steps they take to train potential foremen. The following is a typical and truthful answer: "The men chosen for foremen's positions have generally received a good general education, and to this is added training on the technical side. Whilst undergoing training they have opportunities of proving their ability to control others before actually being placed in definite charge. The same remarks apply to forewomen, who advance from junior to senior grades according to ability." We should be surprised if any other action was taken, but, actually, there should be two riders:—(1) If no one on the firm is adequately trained, an outsider is brought in, and (2) preference may under circumstances be given to brothers-in-law and the like. One might legitimately ask—Why is all this unnecessary work being undertaken, as those responsible must know that finality cannot be reached? Vocational suitability, at least so far as this country is concerned, is another example of wasted effort. Before this subject can be rationally studied, the problem of the suitability of the expert for his job must be finally settled. There is the classic instance of a newly-appointed (and subsequently successful) general manager of money-losing concern being turned away as useless by a female suitability expert. British Government Reports show that a system of rest pauses has increased turnover in one factory, but in a similar concern has decreased it, owing to the impossibility of standardising human nature.

The solution of the problems arising from all these activities is merely the induction of clear thinking amongst factory executives, associated with a knowledge of the underlying principles which created all these unwanted and entirely superfluous associations wrestling with, what is in the last analysis, the standardisation of human beings and their mental and physical make-up.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

The Late Mr. Cole-Estep.

To the Editor of The Foundry Trade Journal.

Sir,—No members of the Institute of British Foundrymen, and particularly none of those who joined the expedition to the International Foundry Exhibition and Congress in Detroit in 1926, can learn unmoved of the passing at so early an age of Mr. Cole-Estep.

Those who journeyed with him in the United States, sojourned with him at American hotels, and had the benefit of his kindly guidance, feel towards him as to a dear friend. They are touched to the quick by the thought that they will never see his face again, nor hear his courteous voice, with its characteristic transatlantic clearness of enunciation, smoothing away their difficulties and making obscure paths plain.

I well remember the general consideration for the feelings of others which governed his conduct of the tour. How he tried to give each delegate in turn an opportunity of expressing his feelings to our American hosts, and how carefully, when the occasion was momentous, he selected just those of us who were best able to do it justice, and to say the things we all felt.

To know him was to like him, and it may be some crumb of comfort to those closely associated with him in their daily life, to know that there are many others, far across the sea, who feel his loss almost as keenly as they themselves do.—Yours, etc.,

Frank Russell.

General Refractories, Limited, Sheffield.
October 5, 1929.

To the Editor of The Foundry Trade Journal.

Sir,—We are disturbed to learn of the death of Mr. H. Cole-Estep. It is, indeed a great shock, especially to those of us who visited the 1926 Convention in the U.S.A. The preparations and welcome given to us by Mr. Cole-Estep and his colleagues will never be forgotten. The English-speaking nations and the foundry trade in particular can ill-afford to lose, at an early age, such a clean-cut character as carried by Mr. Cole-Estep.—Yours, etc.,

E. Longden.

158, Manley Road,
Whalley Range, Manchester,
October 6, 1929.

To the Editor of The Foundry Trade Journal.

Sir,—It was with extreme regret that I read the news of the death of Mr. Cole-Estep in your issue last week. I am sure that all of us who crossed the Atlantic three years ago to the International Convention at Detroit will feel that we have lost a real personal friend, and the news of his early death will come as a blow to most of us.

Cole's cheerful and sunny personality impressed men wherever he went, and his work on behalf of the British and American Associations will long be remembered.—Yours, etc.,

H. Winterton.

Kelvinvale Mills,
Maryhill, Glasgow, N.W.,
October 7, 1929.

[Several other tributes have been received from equally prominent members of the British Foundry Industry.—Editor.]

Nitralloy.—Messrs. Nitralloy, Limited, King Street, Sheffield, inform us that Nitralloy steels, which have been referred to in our columns recently, are now being manufactured in this country by their licensees, namely:—Messrs. John Brown & Company, Limited, Atlas Works, Sheffield, and Messrs. Thos. Firth & Sons, Limited, Norfolk Works, Sheffield.

French Foundrymen's Association.

The Eighth Foundry Congress, organised by the French Foundry Technical Association, is to be held this year, under the patronage of the Minister for Technical Education, on October 25 and 26 at the National School of Arts and Trades, 151, Boulevard de l'Hôpital, Paris. All foundry technicians wishing to take part in this Congress should communicate with the Secretary of the Association at the above address.

October 25. First Session.—Registration of Delegates. Opening of the Congress. Presidential Address by Mr. E. Labbe, General Director of Technical Education. Presentation and discussion of the following Papers:—

Production of High-Strength Grey Irons in the Electric Furnace, by E. Valenta, of the Skoda Works, Czecho-Slovakia (official Exchange Paper).

Cast Alloys currently used in Great Britain, by H. Turner, M.Sc., Lecturer in Metallurgy at the University of Birmingham (British Exchange Paper).

Some Hints on the Practice of Mechanical Moulding, by G. Toussaint, Foundry Proprietor, Haybes-sur-Meuse (Ardennes).

Second Session.—The Production of Castings for Use in Agricultural Machines, by H. Bernstein, Chief Metallurgist of the Deere Company, President of the Grey Iron Castings Committee of the American Foundrymen's Association and of the A.S.T.M. (American Exchange Paper).

On the Shear Test, Report of the Belgian Foundry Technical Association.

Tests for Cast Irons, by A. Le Thomas, Consulting Engineer, and R. Bois.

The Effect of Agitating Liquid Cast Iron, by F. Girardet, Foundry Proprietor, St.-Dié, (Vosges).

October 26. Third Session.—Scientific Research in Metallurgy: Some Results applicable to Iron Foundry Practice, by J. Pascal, Manager at Messrs. Diedriche at Bourgoin, Isère.

Changes Undergone by Cast Irons at Elevated Temperatures, by A. le Thomas.

Value of the Modulus of Elasticity of Pearlitic Irons, by Mr. de Leiris (Indret Dock Yard).

Fourth Session.—Foundry Organisation, by G. Rivoire, engineer.

Special Cast Steels and their Use in connection with Pipe Fittings and Cocks working under High Temperatures, by J. Galibourg, of the Central Polytechnic College.

Heat and Corrosion Resisting Irons, by A. Ballay, D.Sc.

Address by the President of the Association.

The closing banquet, followed by a concert and dance, will be held at the Hotel Lutétia, 43, Boulevard Raspail, Paris, under the chairmanship of Mr. François Poncet, Under-Secretary for the State for Technical Education and Fine Arts.

Book Review.

Opercula (London Coal Plates), sketched by Æsculapius, junior. Obtainable from the author, The Mount, Melton Constable, Norfolk. Price 2s., post free.

This book should be in the possession of every foundryman who takes an interest in the history of his craft. It is unique in character, being a collection of 150 sketches of coal-hole covers, made by a medical student of 60 years ago during his spare moments. The "medical student," Dr. Shepherd Taylor, is now 90 years old but, happily, still active. We feel sure that, in spite of the age of these castings, the patterns for their manufacture still exist. It would be interesting if foundries making this class of castings would purchase this little book and tell us whether anything like completeness has been achieved or if many other designs also exist. The word "Opercula" has been adopted from the plural of a Latin word meaning a cover.

Random Shots.

I had made a special mental note to tell you all about the Seven Sins of Founding, as shown at the recent exhibition, and then my very good friend the Editor went and took all the wind out of my sails by reproducing the lot of 'em, with full particulars! However, I can truthfully say that the black-and-white reproductions don't really do justice to the originals, which were unusually striking. The general colouring was typical of the average foundry—unless it were just a shade too clean—and the gentleman with horns and a tail stood out in crimson contrast. In the reproductions you might without any great difficulty mistake him for the foundry manager!

* * *

I see that Dr. F. E. Smith has been appointed to succeed Mr. H. T. Tizard at the Department of Scientific and Industrial Research—at least, the official appointment is to be secretary to the Committee of the Privy Council for etc., etc., . . . but what it really means is that those persons who have business with this department will now come chiefly into contact with Dr. Smith and his policy—among them the Research Associations. Mr.Tizard has, I believe, taken up work of a different character.

* * *

Mention of his name reminds me that he contributed an article—about this time last year—to a series on, I think, "Careers," in one of the illustrated monthly magazines. I remember commenting on the fact in this column as a sign of the times. Now, rather curiously—since Dr. Smith was for a time at the National Physical Laboratory—I find that another illustrated monthly magazine has published an article descriptive of that institution. It was, so far as I could tell, a fair and accurate article, officially authorised and adequately illustrated, but I could not help wondering whether the somewhat austere experts who reign at Teddington were altogether pleased with its occasionally flippant tone. They were, for instance, described as "wizards to the nation," and more prominence was given to novel gadgets than to important work.

* * *

You may have seen the article in question, as it appeared in a magazine that is chiefly read by men. The editor does occasionally throw in a love story as a sop, I suppose, to stray wives or daughters who may scan the pages; but the rest deal with detectives, beachcombers, Mr. P. G. Wodehouse's admirable Jeeves, the latest fantasies of Sir Arthur Conan Doyle, and a collection of puzzles that really do puzzle. Now, do you recognise it?

* * *

I can never quite determine how far this attempt to "popularise" science is a good thing. After all, a boy with a wireless set or a man with a car learns more electricity or mechanics in that way than from any quantity of lectures or articles, and I am inclined to think that the gradual mechanisation and electrification of life will be the best teacher of popular science that can be devised. The other kind of popularisation often makes a thing so popular that it is meaningless.

* * *

The story is told of an Eastern potentate who was staying in London and who, in the course of a meal, began to make frightful and alarming noises. The *maître d'hôtel*, who had just renewed the supply of quill tooth-picks on the royal table, asked anxiously what was the trouble. "His Majesty," said the interpreter, "has already eaten two of those things, and he wishes you to know that he does not like them."

Marksman.

High-Test Cast Iron.*

By R. P. Lemoine (Paris).

Introduction.

The present Paper deals with the actual state of the production of high-test cast iron in Europe and chiefly in France.

So much has been published on this subject during the last few years in Papers of a purely scientific spirit that one may wonder if all the newly-proposed processes are really applied on a commercial scale, and, among them, which are the most practical and liable of an important industrial development.

It is intended here to examine the subject from this last point of view and then to study the uniformity of results obtained from day to day in routine work rather than the relative value of figures published about tests concerning one process or the other.

The Paper is divided into two main parts: the first reviews the various scientific results which are at the basis of the modern tendency in high-test cast iron production; the second treats of the evolution of the practical side of the question during the last ten years. In this abstract the first section has been deleted.

Use of Steel in producing Cast Iron.

Many foundries became quite expert during the war in the manufacture of cast-iron shells, using some steel in the mixtures. The thorough study of mass production of well-known castings of this kind has resulted in the establishment of definite rules as far as chemical composition and operation of the cupola are concerned. The final carbon content aimed at was around 3 per cent. This figure was recognised at that time as the lowest a cupola could give with a good uniformity; it also can be said that the advisability of lower figures was not then ascertained. The obtaining of this carbon content involved the use of steel scrap in the charge. To contend with a fairly severe impact test, it was thought indispensable to keep the phosphorus low (about 0.10 per cent). In such conditions the silicon was adjusted to the carbon so as to have:—

Total carbon + silicon < (less than) 4.4 per cent.

Under this maximum limit, the silicon content was itself governed by the thickness of walls and by the fact that shells were cast either in green or in dry sand moulds; for instance, a silicon of 1.20 per cent. for a given shell in dry sand was increased to 1.35 per cent. to give the same results in green sand. The remainder of the chemical composition was more or less invariable for any shape of shells; for instance, the optimum analysis for a wall thickness between 30 and 45 millimetres was C, 3.10, Si, 1.25, Mn, 0.80, S, 0.10, and P, 0.10 per cent., and manganese, phosphorus and sulphur were about the same as for any other combinations of carbon and silicon. Cupola charges able to give such final results were chiefly composed of low-phosphorus pig-iron and steel scrap. The object of this last material was, of course, to diminish the carbon and silicon of the pig-iron.

At the same time, the best grade of scrap for the purpose was found to be mild or hard carbon steel (rails) in fairly heavy pieces. The percentage added varied widely from one foundry to the other, not only on account of variations in the analysis of the available pig-iron, but also because the recarburisation of the steel was not the same in every cupola. In some cases the reduction of the carbon content of the final iron with a given addition of steel scrap was more efficient than in others, and the figures had to be established for each cupola. This was, of course, quite a simple thing, done during the first days of manufacture.

The composition of the charges included also scrap of iron from the partial steel mixtures scrap (heads, gates, rejected castings).

In some instances, when shells of widely different size had to be cast the same day, it was found convenient in several foundries to use for them all the mixture suitable for the largest, and merely heat up the moulds of the smallest to a given temperature, so as to obtain for those castings the same rate of cooling which gave the desired results in the largest ones.

All the shells had, of course, to satisfy a set of definite tests (soundness under water and gas pressure). The iron itself was controlled by tensile, impact and transverse tests. The specifications for tensile test were those given in Table I.

Table I.

Test bars cast at:	
Length	200 mm.
Diameter	18 mm.
Machined to:	
Length	100 mm.
Diameter	16 mm.
Tensile strength: more than	15.8 tons per sq. in.

When the specifications of Table I were strictly followed, the usual strength was around 17.7 tons per sq. in. Portevin made an extensive study of such shells and found out that the correct figure of mechanical properties always corresponded to a pearlitic structure; the iron was composed only of pearlite and graphite.

Just after the war, the process used with great success for shells was extended to several kinds of castings like cylinders and heads for Diesel engines. It is always followed even now by some leading firms and a national naval yard in France. In some instances it was found that more phosphorus than was originally used would help much for castings of intricate shape and presenting thin sections. However, practice indicated that the maximum value of the sum: Total carbon + silicon had to be increased with the phosphorus.

From a strictly technical point of view, iron made from a partial steel mix with low or mild phosphorus would have been satisfactory for many applications if it were possible to get a reasonable uniformity of strength throughout a given casting of variable thickness. In fact, it was not the case, and this is illustrated by the figures collected by A. Le Thomas.†

Patented Cast Irons.

Some years ago there appeared on the European market several patented processes claiming to be able to produce high-test cast iron with properties never reached before. The most well-known are the Lanz and the Thyssen-Emmel processes.

The feature of the first is to produce a so-called "Perlit Iron" by casting a cupola-melted iron in moulds heated up to a definite temperature so as to get a definite rate of cooling. This temperature is adjusted to the thickness of the castings, and two or three different mixtures in the cupola are sufficient to cover the range of common thicknesses. The chemical compositions look much like those of irons from partial steel mixtures with a little less silicon. The claims of the Patent are well known; uniformity of a pearlitic structure, graphite in small particles, etc.

Casting in hot moulds has been practised by various foundries during the war and also many years before, as Prof. Osann himself recalled.‡ The rate of cooling is one of the many factors of graphitisation, and it might as well be governed, if wanted, by the casting temperature.

As for the technical value of the process, two or three points can be raised:—

(1) Pearlite structure has always existed, and its importance in high-test cast iron had been recognised long before their Patent appeared; (2) It is possible that more uniformity is obtained in a given section of a casting, and differences of structure can be smaller than usual between the central part and the outside, but what about two different sections of the same casting? Variations of one to three in thickness of walls are not rare, and it is impossible to have in the mould the necessary range of temperature to give to each one the desired cooling speed, and (3) from the figures published by the patentees it can be seen that, for a given composition of iron, when the mould for a casting 1 in. thick has to be heated up to 200 deg. C., the mould for casting 2 in. thick has to be heated up to 450 deg. C. Which type of furnace has to be used to have the two moulds ready for casting at the same time? What will be the organisation of a foundry making by this process castings of very different sizes and thicknesses?

The Thyssen-Emmel process has for itself the value of a good metallurgical basis. As far as can be ascertained, it allows the direct production, with a cupola, of a cast iron low in carbon and high in silicon. The question as to whether such a performance is worth being patented will not be discussed here, because the author of this Paper obtained, some six years ago, many tons of cast iron with 2.30 per cent. carbon out of a cupola without thinking he had done something new. It can be said that the production of low-carbon cast iron in a cupola is a rather intricate operation if considered (as must be done) from the point of view of regularity and uniformity. It depends not only on the cupola itself but also on the raw materials, and this cannot be dealt with by a patent because conditions always vary from one country to another.

Alloyed Cast Irons.

There appear from time to time in the technical Press, Papers dealing with the influence of some special element on the properties of cast iron. Special elements are, as a rule, expensive and are to be considered only when it is necessary further to improve a given property, the full possible development of which has been reached when using only the influence of common elements and the best process of fabrication.

The same policy has constantly been applied to alloyed steels. An alloyed steel is always a quality carbon steel, a certain property of which is improved by the addition of a special element up to a degree that warrants the extra cost of the operation. Alloyed cast irons seem to be worth consideration for different corrosion problems and some applications in the electrical field; they perhaps will be developed in the near future for resistance to wear when their superiority from this point of view is amply proved. But, when high mechanical strengths only are wanted (tensile, shearing and transverse), they do not seem to be of much interest up to now, because the full development of such properties as obtainable without these special elements has not yet commonly been reached. As far as mechanical strengths are concerned, alloyed cast iron can be considered as a reserve force to be used for further improvements at the time when the new processes to make high-test cast irons are extensively adopted.

Electric Cast Iron.

The use of the electric furnace to produce cast iron dates back in France to several years before the war. In some electric steel plants they used to prepare their iron for additions (recarburisation of a too-soft steel bath) by merely melting steel turnings and scrap and carburise them with coke or anthracite in special heats of an electric furnace. This simple process was extensively

* Abstracted from the French Annual Exchange Paper of the Association Technique de Fonderie to the American Foundrymen's Association.

† A. Le Thomas—"Testing Cast Iron." Transactions American Foundrymen's Association, vol. XXXIV, pp. 690-745, 1926.

‡ Osann—"The Manufacture of High-Quality Cast Iron." FOUNDRY TRADE JOURNAL, vol. 39, No. 644, pp. 448-449. Translated from "Die Giesserei."

used during the war when there was a shortage of pig-iron due to many blast furnaces being destroyed. It produced only pig-iron and it was not intended at that time to get direct from the electric furnace an iron suitable to be cast into moulds.

The question has since been much studied, and the ability of the electric furnace to give cast iron of very good mechanical properties is now well proved. Its two principal advantages are: (1) If a basic bottom is used, there is a possibility of getting any final analysis out of practically any kind of raw material, and (2) refining of the graphite.

The second point is much more intricate and difficult to explain. Refining of the graphite has been attributed to superheating, and at least three theories have been put forward,* but the fact remains positive that superheating sometimes fails to refine the graphite.† Prof. Osann seems rather inclined to think that refining is chiefly due to the following mechanism: As the iron remains a long time liquid in the electric furnace, "kish" or "hypereutectic" graphite has the opportunity to get out of the alloy; then graphitisation takes place only at the true stable eutectic temperature when the iron cools down in the moulds, and, in consequence, the graphite formed is fine. It is quite possible that the truth lies in the association of all the theories already mentioned, and perhaps also some other one dealing with dissolved gases and their influence on the time and shape of graphitisation.

Three particulars are of interest:—(1) As far as the chemical composition is concerned, it is easy in this case and it is advisable to follow the modern tendency to have a low total carbon coupled with a high silicon; for instance, 2.40 to 2.60 per cent. carbon with 2.80 to 3.00 per cent. silicon. The advantages of this have been exposed in the first chapter of this Paper, and there is no need to repeat them; (2) manganese has to be kept rather low on account of low carbon and sulphur; if possible, it is fixed at 0.40 per cent. For the phosphorus 0.15 per cent. seems to be a reasonable figure, and (3) sulphur is cared for by the furnace itself if a basic bottom is used, which is a good proposition in the present case. It can be seen that the contents of the three last elements agree with the scientific results.

As for the process itself, it is much better to start with steel scrap as the main raw material and carburise it, than to start with a charge having approximately the final composition wanted. It is perhaps a little more difficult to run the heat, but the possibility of obtaining a very fine graphite is much larger. This solution is also interesting from the point of view of cost, as a bad steel scrap can be used without inconvenience and such material is generally two or three times cheaper than pig-iron.

Powdered coke, graphite or anthracite is mixed in liberal quantities with the cold scrap and no special difficulty is found in getting 2 to 2.40 per cent. C in the bath just after melting down. The desired point is reached by the subsequent action of a carburising slag during a quarter to half an hour, and the operation is controlled by a quick chemical analysis or by examination of a broken chilled sample; the latter method is not very accurate, because the iron is all white at this time, but the coarseness of crystallisation is often a sufficient feature of appreciation.

When only steel scrap is used, silicon has, of course, to be added, and the question arises, is it better to add it with the cold scrap or afterwards when the bath is liquid? The writer prefers to add silicon in small quantities at a time when the carbonising operation is finished and the temperature rises; the effect of each addition is controlled by recording the depth of chill and size of grain of small pointed samples cast in green sand.

This practice is the best one to be sure that in spite of eventual erratic losses of silicon, the remainder of this element is well adapted to the actual carbon content of the iron.

When the heat is well managed, the resulting cast iron gives with the test-bars used (a partial steel mixture) more than 15.4 tons per sq. in. It has very fine graphite, appearing chiefly in dots under the microscope, and uniform pearlite. The homogeneity of such cast iron is very good, and no appreciable difference can be noticed in constitution and structure between the central parts and the outside of a casting 2 in. thick.

Duplex Process.

The main objection against the use of an electric furnace to melt cast iron is the cost (current, electrodes, amortisation, etc.). The power consumption in the method just described varies around 600 kw.-hours per ton of liquid iron, and it is clear that its interest is limited to countries or districts where electric current is very cheap. Moreover, it can be said that if the electric furnace is perfect for refining, it is expensive for melting and not very convenient to carburise steel beyond a certain point. For those purposes, a foundry cupola is much more efficient. This consideration is at the basis of the duplex process, which consists in melting the steel scrap and carburising it in a cupola and transferring the liquid iron in an electric furnace, where it is refined after its composition has been corrected, if necessary.

A short description of the operations is in order. The chemical composition aimed at is the same as previously indicated. The steel scrap is charged in the cupola and everything is done in order to get an iron running at the tap hole with about the final carbon content wanted. The liquid iron is transported in ladles to the electric furnace, and, at the same moment, the carbon is tested. When the result is known, corrections are performed, if necessary, by:—(1) Adding soft steel scrap in the furnace if the carbon is too high, and (2) building up a carburising slag if the carbon is too low.

The first correction is more easy and accurate than the second, but, anyway, the two mean a loss of time and consumption of current, and their necessity must be avoided as far as possible. When the carbon is correct, a small deoxidising slag is made up, if not already done for recarburisation purposes, and as soon as the temperature rises, additions of silicon are made. The results are controlled as in the preceding process on small test-samples. The quality of the final product is the same as if it were completely prepared in the electric furnace, and its price is much lower in normal conditions.

The power consumption depends largely upon the organisation of the shop. A duplex operation needs from 35 to 50 minutes of work at the electric furnace (charging and tapping included) when the furnace has not had time to cool down much between two operations, and the power consumption is about 125 to 175 kw.-hours per ton. If the melting capacity of the cupola is not well adapted, if there is a delay between two operations, or if much work is needed to correct the carbon content, the power consumption increases. In any case, however, there is a substantial difference with the single process from this point of view.

When trying to make a fair comparison of cost between the semi-steel, for instance, and the duplex processes, two important features are to be considered:—(1) Cost of raw materials, and (2) cost of electric-furnace operation.

In many parts of Europe, steel scrap suitable for the duplex process is so much cheaper than the low-phosphorus pig-iron necessary for semi-steel that there is a substantial interval in which the cost of electric-furnace operation can vary without losing its economic advantage. Even if an extra commercial value is not considered for the electric final product, it is often found that its manufacture remains interesting up to the normal price of electric current in several industrial districts. Moreover, a duplex equipment gives a foundry the possibility of producing several kinds of special cast iron and even cast steel, a point worth being considered commercially.

Cupola Low-Carbon Cast Iron.

It is a fact that long practice with the duplex process has taught much about the production of a low-carbon cast iron with a cupola. The compelling need to cut down current consumption has obliged the practical man always to try and avoid carbon correction in the electric furnace, and, for this, to get the right contents at the tap-hole of the cupola. Such a performance has been attained gradually.

Much has been said and published about the carburisation of steel scrap in a foundry cupola, but the writer's opinion, based on extensive experiments in five countries of Europe, is that this operation can be divided into two main steps: carburisation of solid steel scrap before melting and carburisation of liquid iron after melting.

(1) When considering a given cupola and a certain kind of soft or mild steel scrap, it is always possible to combine the weight of charges, pressure and volume of air, so as to get an iron with not more than 2.00 per cent. carbon when it melts down and falls in drops in front of the tuyeres. The only important point to reach is to have a high melting speed, and we will try to explain this.

It is obvious that the scrap melts down only when its melting temperature gets lower than the temperature of the combustion zone of the cupola. As it goes down from the charging door, it picks up carbon at a rate depending upon its nature, thickness, etc., and it arrives in the combustion zone with a certain carbon content varying with the time of travel. If the temperature of this zone is high enough, the carburised scrap melts down; if not, it remains there and continues to pick up carbon until its melting point is sufficiently lowered. It appears, then, to be a relation between the temperature of the combustion zone and the carbon of the scrap when it melts down; the higher the temperature, the lower the carbon. But this is only true providing the high temperature is secured by a quick burning of a moderate percentage of coke and not by large quantities of coke burnt at low speed.

It is a mistake to think that much coke is needed to melt all steel charges in a cupola; 12 to 14 per cent. of the charges are sufficient. If, for instance, 20 per cent. is used, it becomes difficult to obtain low-carbon cast iron, because the time necessary to burn all the coke is long, the melting speed is low, and the scrap has time to pick up too much carbon during its travel from the charging door down to the combustion zone. A quick burning of 12 to 14 per cent. of coke and a quick melting are obtained only by increasing the volume of blown air, and if the tuyeres section remains the same, by increasing the pressure.

As a matter of experience, the writer can state that he has obtained with the same cupola and same charges an iron with 2.00 or 3,00 per cent. carbon when it fell liquid in front of the tuyeres when the air pressure was 450, or 160 millimetres of water. In the first case the melting speed was almost twice as high as in the second; that is to say, twice as much iron was melted per hour and, of course, twice as much coke burnt in the cupola. That is the entire secret of the operation.

(2) It is common in Europe to use cupolas with bottom receivers; a certain capacity is provided in the apparatus itself under the tuyeres' level; this capacity is full of coke, and the iron is collected and kept hot there before being tapped. Obviously the iron has the opportunity to pick up some more carbon in such bottom receivers, and it actually does so to an extent varying with the time of contact with the coke and with its own chemical analysis.

(To be continued.)

* Piwowarsky—"Progress in the Production of High-Test Cast Iron." Transactions American Foundrymen's Association, vol. XXXIV, pp. 914-985, 1926.
† Loc. cit.

The Kaiser-William Institute for Iron Research at Düsseldorf.

During the Annual Autumn Meeting of the Institute of Metals, which was held in Düsseldorf, Germany, last month, a party of members visited the Kaiser-William Institute for Iron Research. This Institute was founded in June, 1917, and its work is confined by law to scientific research in iron and steel. At the time of its inauguration in a building of the Rheinische Metallwaren- und Maschinenfabrik, a full account of the history of its formation and of its objects appeared in the German Press. If this programme has not been carried out in its entirety, the delay must be attributed to the difficulties which followed the war. In the following years the Institute has made steady, if somewhat slow, progress, and the various departments have shown continual expansion as necessitated by the rapidly growing requirements of research. The rapid growth of the staff, which on October 1, 1927, consisted of 95, including 27 University graduates, and the necessity of increasing the laboratory room, led to the building of a new wing at the eastern end of the Institute. Now that these new rooms are in use and the grouping of the various laboratories has been reorganised, a short account of the present arrangements can be given.

Internal Organisation.

The internal organisation of the Institute involves a division of the work into several departments, among which is the administrative section. The basement contains, in addition to the central-heating plant, the general storerooms, a small refrigerating plant, the main switch room and the accumulator room of the laboratories of the ore department. On the ground floor are the workshop, the housekeeper's rooms, storerooms for the steels required in research, a conference room for the mechanical testing department, part of the physical laboratories for magnetic and optical pyrometric measurements, a room with high-frequency equipment for special physical and chemical investigations, the technical research room and the large melting house of the metallurgical department. On the main floor are situated the chief administrative rooms, the library, a series of working rooms for the superintendents and the higher assistants in the laboratories of the chemical department, the principal part of the physical laboratories, and, finally, the workrooms of the metallography department, which investigates the structure of the metals. In the top floor, in the middle of the building, are the high-frequency plant for the X-ray room, the electrical stores and a storeroom for physical apparatus not in regular use.

Equipment and the Work of the Departments.

The problems of the ore department comprise the development of processes for the utilisation of low-grade iron ores, especially of those of which Germany has large deposits. Generally, the structure of the ore is first examined microscopically in reflected and transmitted light; from the results obtained, conclusions are drawn as to the most likely methods of concentration which can be applied, and these are then tried out on a laboratory scale with small samples. The most satisfactory method is then thoroughly tested on a work's scale, for which purpose a variety of apparatus is installed, including stone-breakers, various types of grinding mills, grading apparatus and electromagnetic separators of various types. The second laboratory contains a wet magnetic separator of the roller type, an agitator, classifier and cylindrical continuous filter with settling vat. This room also contains a variety of flotation apparatus and a small electrically-heated rotating furnace. In the investigations carried out in this department, an attempt is made to discover not only the degree of concentration that is possible from the point of view of the present position of the technique of ore-dressing, but at the same time to establish from the physical nature of the ore the greatest possible concentration that could be made under ideal conditions. It has already been shown that usual methods of calculating results is insufficiently accurate, and new principles of determining the concentration factor from the experimental results have been developed, together with methods for calculating the economically highest factor obtainable. On these principles a critical experimental survey of methods of dressing any iron ore is undertaken, and, if necessary, recommendations are made for improving the recovery or the grade of the product.

In the mechanical testing department the usual methods of testing materials are subjected to critical tests. Special methods of testing are worked out and comprehensive researches are made on the effect of composition, method of manufacture, thermal and mechanical treatment and testing temperature on the mechanical properties of constructional materials, with special reference to the use to which they are to be put. In the main testing room are a group of tensile testing machines (Pohlmeyer, Losenhausen, Amsler, Krupp, Schopper), with capacities up to 50 tons, together with pendulum transverse testing machines of 75 and 15 m. kg., apparatus for static and dynamic fatigue tests, hardness-testing machines of the Brinell, Rockwell, Shore, drop-hammer, pendulum and scratch type; machines for testing the workability of materials and machines for carrying out wear tests.

The mechanical technology laboratory contains an outfit for cold-rolling, a draw-bench for rods and an electrically-heated annealing furnace for investigating the working properties of metals. The melting house contains a compressed-air hammer of 1½ cwts. and a belt-driven drop-hammer of 5-cwt. drop-weight. The principle objects of the research in this department are determinations of the power requirements and energy consumption in mechanical technological methods of changing the shape of metal articles. In collaboration with the mechanical testing department, researches are made to determine the relation between change of shape and strength of materials, which is used as a basis in treating this method of working mathematically. At the same time, the changes in the properties of materials induced by mechanical working and heat-treatment are investigated.

Melting Shop.

The new melting house of the metallurgical department contains a 30-kw. high-frequency furnace, a series of Krupp Kryptol resistance furnaces, a gas-fired and an oil-fired crucible furnace. The very great elasticity in the control of the high-frequency apparatus permits melts of any weight from 100 grams to 1 cwt. to be made. The special metallurgical conditions of melting in this furnace have been the object of an extensive series of researches, which have yielded remarkable results as regards the purity of the steel produced in them. The capacities of the Kryptol furnaces vary from 4 to 25 lbs., whilst those of the two crucible furnaces are each 66 lbs. The temperature that can be obtained in the oil furnace is sufficient to melt soft steel. For annealing and general heat-treatment work there are four gas-heated muffles, two Krupp radiation furnaces, a gas-heated and a high-frequency induction-heated salt-bath. The hammers mentioned above are used for forging small test castings as well as for testing the forging properties and red-shortness of steels produced in the experimental furnaces. The change of volume on solidification of steel and cast iron can be followed systematically by means of a number of contraction meters. Large-scale researches with the object of discovering methods of producing high-grade cast iron have been in progress for some time.

The laboratory for thermal analysis (division of the physical department) is devoted to a study of the polymorphism of pure iron and to the establishment of equilibrium diagrams of the most important alloying elements with iron. For these purposes it is equipped with the necessary furnaces (Tamman, Vacuum and tube types), and with apparatus for the automatic taking of differential and time-temperature cooling curves, also for following internal reactions which take place with great rapidity.

X-ray and Magnetic Outfits.

The X-ray laboratory is concerned chiefly with researches on the structure of iron and its alloys, and of the changes thereof caused by cold work. Investigations are also made of the value of X-rays for detecting flaws in welds and castings. The apparatus comprises high-tension electrical plant, X-ray tubes with the necessary vacuum equipment and photographic apparatus for the different methods of examining structure.

The magnetic laboratory is fitted out with apparatus for the systematic study of alloys with special magnetic properties; this includes a Koepsel apparatus for obtaining magnetisation curves, an Epstein apparatus for the determination of the magnetic properties of dynamo and transformer sheet, and apparatus for ballistic measurements. An apparatus for magnetometric determinations at high temperatures is being built in a room on the ground floor.

The optical pyrometric laboratory is engaged with problems of temperature measurement, especially with optical pyrometers, the determination of the radiation constants of technically important substances, and of the heat emission by means of an infrased spectrograph and their importance in the heat transfer between gases and solids. For the determination of the thermal constants of substances of importance in metallurgical processes, a precision vacuum calorimeter and a water calorimeter are available. This laboratory has carried out important work in developing a pyrometer for the measurement of the true temperature of hot gases.

Chemical Laboratory.

The chemical department contains, besides the principal laboratory, with the usual balance room and washing room, numerous smaller laboratories for special research. The principal laboratory is used for the analysis of the materials, *e.g.*, iron, steel, alloys, ores, slags, etc., used in the various researches throughout the Institute for the critical testing and improvement of these methods of analysis and for working out new methods. The laboratory is well equipped with the necessary apparatus, as well as with that required for electrolytic determinations, for gas analysis and for the determination of nitrogen, oxygen and slag in steel. An apparatus for the determination of oxygen in iron and steel by the hot extraction method, using high-frequency heating, will shortly be put into operation in the room on the ground floor previously mentioned.

Mention should also be made of the apparatus for electrometric titrations and for microchemical analysis, as well as of the arrangements provided for carrying out extensive corrosion researches.

The metallographic department is supplied with numerous micrographical outfits (Martens, Leitz, Le Chatelier, Reichert and Zeiss) for the examination of the microstructure and the preparation of photomicrographs. The necessary auxiliary apparatus for preparing sections of metals, ores and slags, for etching these, and for the photographic work is naturally available.

The workshop is engaged in preparing the materials for the scientific departments, espe-

cially the physical and mechanical departments, in making and repairing apparatus, and in erection work. The equipment comprises a number of draw-benches, drilling machines, lathes, saws, shaping machines and round and flat planing machines. There are also provisions for fine mechanical work, for electrical installation work and for the construction and repair of electrical instruments, as well as a carpenter's shop.

The Institute has, therefore, at its disposal all the most important apparatus for tackling its principal problems and for its work in connection with the establishment of the scientific principles for the production and working of iron and steel. Besides this general scientific work it is equipped for doing work of a more technical nature which at any time may become of importance to the industry.

In all these researches the principle has been vigorously emphasised that the results obtained shall, as far as possible, be made generally available by publication in a suitable form. With this object in view, the results are published in the first place in the "Mitteilung aus dem Kaiser-Wilhelm Institut für Eisenforschung," and subsequently in suitable technical journals. Commencing at the beginning of 1920, ninety-one Papers have been published in nine volumes of the "Mitteilungen," and these testify to the manifold research activities of the Institute in all branches of iron technology.

Whilst full credit must be given to the German iron industry for its assistance, financial and otherwise, which has proved invaluable in providing considerable apparatus and ensuring the smooth running of the Institute, it must not be forgotten that the conversion of a building, originally intended for totally different purposes, into a technical Institute, is obviously not an ideal arrangement owing to difficulties in planning the lay-out of the various departments. The provision of a permanent home for the Institute is, therefore, a most desirable object, and the town of Düsseldorf has placed at the disposal of the Institute an ideal site of ample dimensions. It is hoped, therefore, that the industries of Germany, especially the iron industry, will help to develop these plans in the near future, not only for the good name of the German industry, but also for that of German science.

The Light-Castings Industry.

A strong appeal to the Labour Government to assist the light castings industry in its efforts to counteract foreign competition was made by Mr. George Scotland, a director of the Falkirk Iron Company, at a gathering of the firm's employees. In the course of his speech he said that unfortunately the state of affairs in the light-castings industry was not at all as they would like. During the last two years Falkirk and district had been experiencing a very trying time and there had been a serious depression.

He was sorry to say that the end of that depression was not yet in sight. They had now a Government which he sincerely hoped would give full support to the adherents of every party. Thousands of new houses which had been badly needed were about to be built, and in this connection he would like to point out to the Government that these houses were being built for British people, paid for by British money, subsidised by British taxpayers, and therefore ought to be equipped with goods made and supplied by British workmen. He thought it deplorable that while hundreds of men were out of work, we were bringing into this country thousands of pounds worth of foreign-made goods to fit into British houses. Every one of these articles could be made at home by our own people. It was the duty of the Government to see that such a state of affairs is not tolerated in this country.

The Buyer's Boomerang.

By "Onlooker."

There are all sorts of wise saws and proverbs about people getting their just deserts in this world, and although owing to one cause and another the application very often misses fire, there are instances when it can be said with a fair amount of certainty that some particular "bird is coming home to roost." In this respect buyers cannot claim any immunity any more than the rank and file of humanity, and the various sins of commission and omission to which they, as a body, are prone will usually find them out at some time or other.

In the very early days of the science of buying it was thought that nothing mattered except price, and it is much to be feared that the world still numbers many members of a cult still upholding this strange belief. The inwardness of such a plan lies in the necessity of tying down the seller in every possible way, so that willy-nilly he is unable to wriggle out of a bargain into which he has usually been goaded with a fair amount of bluff. Such action on the part of buyers has been responsible for the setting-up of more than one sellers' association, which usually means dearer prices for the consumers in the long run.

As far as metals are concerned there is little fear of trouble for users when virgin metals are in question, since upon the unfailing purity and high standard of the various brands of copper, tin, lead and spelter stand the reputations of many companies of world-wide renown. Quite another problem, however, has to be faced in considering the great scrap-metal family, which, covering as it does a very wide range, leaves many devious ways open for the undoing of injudicious purchasers. Although definite trade descriptions exist in this country by virtue of which business in old metals is made possible, no set specifications exist which can compare with those drawn up by the National Union of Scrap Manufacturers in the United States. That is not to say that complaints are frequent, for if there is no question of the good name of a great refinery being at stake, as in the case of ingot copper or wirebars, it must be remembered that a dealer in scrap metals depends upon his good name for a continuance of profitable trading with his clients.

Human nature being what it is, one can state fairly definitely that square dealing begets a friendly spirit, and if a man is known by his friends, then a buyer is known by the bargains he drives. Let a buyer achieve a reputation for cheeseparing in fixing the price at which he is prepared to purchase, and two things are almost certain to happen sooner or later, at any rate in the world of scrap metals; merchants and dealers will come to the conclusion they are wasting their time and will go elsewhere with their wares, or, in putting up offers, prices will be named which will stand being reduced. The buyer who thinks he has a bargain because of his success in beating down the price of the seller is falling into very serious error and living in a fool's paradise. But this policy of never clinching a bargain unless some reduction is made in the quotation goes deeper than that, for it is tantamount to a vote of no confidence in the seller and a disagreeable suggestion that he is constantly trying to overreach his clients by jumping them for more than his legitimate due. This breeds a feeling of suspicion and incites the supplier to adopt similar tactics in order to get his own back.

Inspection of most kinds of scrap metal is far from being easy, but when it is a question of dealing with small stuff in bags or casks the job becomes extremely hard and can only be thoroughly done by incurring a certain amount of expense. Manufacturers melting a big tonnage of scrap are compelled to take a good deal of it on trust, and since the cheapest way to handle incoming scrap is to avoid a second handling, much of it of necessity goes straight to the foundry without any laboratory test being made on a run-down sample. In effect, what happens to the niggardly buyer is that he becomes unpopular, does not receive necessarily what he thinks he has bought, although he would find it extremely hard to state definitely that a faulty delivery had been made. What is more, there grows up a tendency among sellers to give him a miss, and as a result he often loses the chance of really good stuff, which goes to his competitors who have a better reputation for giving a fair and square deal.

The Effect of Moulding Methods on Estimating.*

By Oberingenieur Küster (Dentz, Cologne).

[*Extract.*]

The continual complaints of price-cutting which are received at all the meetings of the branches of the Association have led the Association to advocate uniform methods of estimating for many years past, this end having been achieved by publishing examples of estimates. The cause of the great divergence in prices is the absence of any uniform method of estimating and the difference in foundry equipment. The publication of the Harzburg Pamphlet has afforded a sound basis for uniform methods of estimating in foundries. Based on the price of the liquid iron and the productive time plus overhead charges on the latter, the productive time (or productive labour) is the factor that has the biggest bearing on the price of castings. As the prices for iron are fairly constant, whereas the productive working times vary with each casting, the greatest attention must be given to the latter factor. The "Refa" folders for foundry practice afford sound data for estimating working times. Tillmann has published a very useful text-book for estimating the time required to produce machine mouldings. Examples may be cited to show the big effect that accurate time figures have on the price of castings. Various lecture courses on these lines have been arranged for estimators at various centres, and the two courses given in Cologne were well attended.

Starting with the principle of producing as cheaply as possible, the aim must be to design castings as simply as possible and true to the technique of moulding, as the times required for making the castings depend largely on their design. This point has been frequently stressed in the last few years by the Association and others. The method of moulding adopted has, of course, the biggest effect on the times of production, and the most economical method must always be adopted. Slight modifications to patterns enable a casting to be produced much more simply and quickly, so that there must be the closest co-operation between designer and foundry.

In the present state of development of foundry methods, it is not always necessary to have large numbers of castings to produce in order that they be machine-made. By proper arrangement of the patterns, isolated castings can also be produced on suitable machines. Even large castings of 3 to 5 metres (10 to 16½ ft.) long and 1.5 to 2.5 metres (4¾ to 8 ft.) wide can be machine-moulded, so as to curtail considerably the time taken in filling and compressing the sand. Examples taken from practical conditions were given to show how, by adopting suitable moulding methods and equipment, the production costs, and, hence, the actual cost of the costings, can be reduced.

* A Paper read before the 59th Annual General Meeting of the German Foundry Employers' Federation, held at Düsseldorf from September 4 to 7, 1929.

Oil-Sand Cores in the Small Jobbing Foundry.*

By Leader B. Gale.

The use of oil-sand has been discussed to a great extent during the past two or three years. The first Paper, entirely on the subject, to be read before this Institute was given by Mr. F. C. Pulsford at the Leicester Conference in 1914, but it is only of latter years that any large interest has been taken. The majority of Papers given have run on the lines of "Mass Production of Sea-Sand Cores in Large Foundries," and there are still many foundrymen who think that the use of oil-sand is essentially for repetition quantities. The main objection to the use of oil-sand by the smaller foundries appears to be on the grounds of the cost of the mixed sand and the plant necessary to produce oil-sand. At the last meeting of the Branch there was presented an excellent Paper by Mr. West on the mass production of oil-sand cores for motor castings,[1] but the mixing and sand-drying plant illustrated was of such an elaborate and expensive type that only the very large firms could attempt to install. While that plant may be advantageous to that particular foundry, it does not follow that any expensive machinery must be purchased to produce oil-sand. Any foundry, however small, can successfully make oil-sand cores with vastly cheaper costs of the finished castings than with the use of natural-bonded sand cores, and it is proposed to outline the methods of making oil-sand cores in a small foundry, with the least possible capital outlay. The foundry in question is of the size capable of producing 15 to 20 tons of castings per week, employing a few moulders and moulding machines on jobbing work of any description, and with the exception of the core-shop chargehand all labour on core-making is unskilled or semi-skilled.

Sand.

Rock sand, river-bed sand, and seashore sands that are commonly called sharp sand, are all used with a certain measure of success, but from experience the wind-blown sea-sand is preferable. The term "sharp sand" is inclined to be misleading. Sea-sand is termed sharp sand, but a microscopical examination will show the grains inclined to be spherical in shape, and especially so in a wind-blown sand. The frictional action of the grains as they are blown about wears off all the sharp corners. The essential feature of an oil-sand core is its free venting property, and to obtain the maximum of vent channels the sand grains should be of equal size.

A striking illustration of the necessity of even-sized grains was given by Mr. C. W. H. Holmes in a Paper[2] read before the Newcastle Conference in 1924, as follows:—"If a glass jar that will hold one pint is taken and filled to the brim with marbles of the same size, it will be found that one is still able to pour into the jar between ¼ and ½ pint of water. Now, if we consider these marbles to be grains of sand in a core, highly magnified, we shall see that there are considerable spaces between the grains along which the gases can travel, and so long as the particles are rounded and of regular size it does not matter how big or how small they be, we shall still be able to find the same high percentage of spaces. For instance, if we take another jar and fill it with No. 5 lead shot, we shall still be able to pour into the spaces between the shot as much water as we could in the case of the marbles. But if we take a third jar, and after filling with marbles, we run in the lead shot, we shall find that we cannot run in nearly so much water as we could in either of the previous cases."

Wet-sand or dry-sand is another important point. For binders of the paste and gum types, that give a sand with a strong green bond, dry-sand is essential. If the binder is of the thin-oil type or cream type, dry-sand is not a necessity, and excellent cores can be made with wet-sand. With these latter binders, however, water is necessary for mixing, and dry-sand would enable one to keep a constant mixture. If the sand is dry, the water and oil-binder can be mixed in a container and emulsified by stirring violently, or the oil can be added to the sand and the water immediately afterwards. The latter is the easiest method and is quite satisfactory. Should very wet sand be used, no water need be added, and for damp sand a small quantity of water is required. The man in charge of the mixing will quickly form a rough idea of the degree of dampness that is essential. It is obvious that dry-sand is the most satisfactory, as the amount of water can be controlled, but the author is of the opinion that it is not necessary to spend time and money in specially drying the sand. His firm finds it convenient to store the sea-sand on the roof of a large core-stove, and they are, therefore, supplied with dry-sand at no extra cost. If the stock runs out and it is necessary to use sand straight from the railway wagon, it is used as received, and they would not entertain specially drying the sand. Perhaps the drying of the sand is one of the expenses that cause the objection to the use of oil-sand. In a large firm, using tons of sea-sand per day, the cost of drying, as illustrated by Mr. West,[2] is not of great consequence; but to the smaller foundry this is a point for careful consideration, and probably it will pay to use a thin oil binder and wet-sand.

Whilst on the subject of sand one must consider the cost of the sand as compared to natural-bonded sands, and whether the extra cost of sea-sand can be overcome with the use of reclaimed sand. On this subject it is difficult to see any advantage in using old sand. If one considers that the old sand costs nothing and 50 per cent. old sand is used in the mixture, there appears to be a saving in the price of the sand, but from experience this is found to be a fallacy.

In the first place, does one get the old sand for nothing? Assuming that all the castings are knocked out in the same place, one will have a heap consisting of burnt sea-sand in the free state, lumps of partially burnt cores, core-irons, chills, etc., and moulding sand. This has to be riddled to collect all the irons, etc., then one must either throw away the unburnt cores and sieve the fine sand only, or the whole must go through a roller-mill to crush the large pieces. The whole must then be sieved before it can be used for making cores. Is not the cost of reclaiming the sand as much, or nearly so, as new sand? If one persists in using the old sand, one will find that extra binder must be used to make a good hard core, thus the cost of the extra binder balances the saving on the sand. In addition to this, the cores will be found to have very little venting properties, as the broken sand grains and the proportion of moulding sand that is inevitably collected will clog up the pores in the way illustrated with the lead shot among the marbles.

In a discussion before the 1923 conference Mr. H. M. Lane[4] said:—"The last point he would touch was the question of reclaimed sand. They built a laboratory which had 3,500 square feet of space in it, and they had testing machinery there. They installed various kinds of plant and tried to clean the sand. They could do this when it was wet but they had to dry it afterwards, and it cost twice as much to dry as to clean; so the process was cut out from a practical stand-point and abandoned. They could not clean the sand efficiently enough to use it as an oil-sand or along with any other kind of binder."

The Binder.

Core oils and compounds are now supplied by almost every firm who deal in foundry requisites, and any of them can be used in making sea-sand cores. In a short paper the author claimed that the thin oil of the linseed type is the best for general jobbing work, in addition to being the most economical. Linseed oil binders give the strongest and most porous cores. They are also waterproof, a feature that is of utmost importance when using oil-sand in a jobbing foundry. Its one disadvantage is its lack of green bond. Creams have a small proportion of linseed oil in their composition and give a fairly hard core. The porosity of the core is good, and while it will withstand dampness sufficiently long to place cores in the moulds to be cast the same day, it is not suitable for making cores to be rammed up in a mould and left for any long period. Creams give a fair green-bond. The characteristics of pastes are much the same as creams, but the sand has a very strong green-bond. This bond is, however, very quickly lost if the sand is left exposed to the air, and should this occur the sand cannot be used until it has been damped and remilled. When using this type of binder it is necessary to keep all the mixed sand covered with a damp cloth. Gums, which are mainly wood-pulp extract, are not very suitable for jobbing work. The cores have an exceptionally hard skin, but the core in general is weak. They absorb moisture rapidly, and can only be safely used on small cores, where the moulds are to be cast very quickly after the cores are placed. In jobbing work one often finds it necessary to make a cake core and then file it to shape after drying, Linseed cores are undoubtedly the best for this purpose; the core, if properly baked, is very hard throughout. Creams and pastes are very good in this respect, but the gums cannot be used in this manner. As soon as the hard skin of a gum core is filed away the inside is very soft and powdery. For general work the linseed oil binder is the most suitable, and where a green-bond is necessary this can be obtained by mixing 50 per cent. sea-sand and 50 per cent. red moulding sand. This mixture should only be used when necessary, as the clay-bonded sand requires more oil to make a hard core, and the venting properties are not so good as in an all sea-sand core. Speaking on these mixtures before the Birmingham Branch in 1923, Mr. W. T. Evans said:—"These cores, when dry, will be very hard and will stand somewhat rough usage. The skin is exceptionally smooth." Most of the sea-sand mixtures will give a fairly smooth skin, and except when the core is to make a very particular face on the casting, it is not thought necessary to blackwash the cores. Prof. Campion and Mr. J. McEachen said in a paper[5] to the 1923 conference:—"The authors do not recommend blackwashing. Provided a suitable binder and sand grade are used there is no necessity to do so."

Mixing Machinery.

The most costly part of oil-sand is the mixing, as it is here that special plant must be used if successful cores are to be produced. Oil-sand of any type should be mixed in a separate machine. One can, of course, use the mixers that are used for mixing the facing sands, but if so the costs of production are increased, due to the necessity of keeping the machine scrupulously clean after each type of sand is mixed. Particles of facing sand mixed in with sea-sand will spoil the venting properties of the cores, and, on the other hand, green oil-sand is not a very good addition

* A Paper read before the East Midland Branch of the Institute of British Foundrymen.

1 F.T.J., April 18, 1929.
2 F.T.J., June 26, 1924.
3 Loc. cit.
4 F.T.J., June 28, 1923.
5 F.T.J., June 14, 1923.

to facing sand. There are many types of mixing machines, and the cost and type is one that must be decided according to the quantity of sand that is required. Various writers have recommended the roller mill, but if the rollers are heavy there is a danger of crushing the sand grains. Mr. West overcame this difficulty by having the rollers made specially adjustable. This, of course, is adding expense to an already-costly machine. Mr. Evans has spoken of the double cage mixer as an ideal type of oil-sand mixing machine, but the greatest difficulty here is in keeping the machine clean. He mentions that the "sticky mess" that gathers round the pins of the machine can easily be removed by sand blasting the machine, but if one is not able to employ this method of cleaning one must discover the time required to clean the machine by hand before taking to this method of mixing. Then there are the dough-mixing types of machines. These are perhaps the most popular mixing machines, and they are very efficient. The cost of machines of this type is not cheap, and the cost of renewing the blades must claim attention. For mixing oils and creams, a paddle mixer is quite suitable, and is the cheapest style of machine that can be purchased. Also the renewal of the blades can be made in one's own foundry at a cost of two or three shillings per set. Ordinary cast-iron blades will mix upwards of 300 tons of sea-sand before they are worn out.

Core-Making.

It should be understood that for all cores, where a green-bond is not necessary, the mixture is 40 parts of new sea-sand to one part of thin oil binder, and where a green-bond is desirable the mixture is 40 parts of new sea-sand, 40 parts of red moulding sand, and 3 parts of the thin oil binder, mixed in a suitable paddle mixer.

The cores are made generally from core-boxes supplied by customers. When cores are placed in the mould with the joint horizontally, they are made in halves on flat plates, and placed into the moulds unjointed. Considerable time is saved in this way, and very little trouble has been experienced, due to the cores being unjointed. Should a valve body core be required to stand vertically in a mould, a half core is made and dried sufficiently hard to withstand handling, and then a green-half is jointed on to it and the whole baked. This method is quicker than jointing two dried half cores, and dispenses with the necessity of making packing pieces or formers that would be necessary were the cores to be made whole, whether in a bonded sand or not. Where cores have overhanging pieces or are of such irregular shape that they cannot be dried directly on to a flat plate, the red mixture will get over the difficulty.

Oil-sand mixtures are inclined to "clag," especially when using wood core-boxes, but dusting the boxes with parting dust, or wiping them with a paraffined-cloth, will overcome this difficulty. Oil-sand cores will stick hard to the plate when dried, and to remove them without damaging the face of the core the plate must be given a sharp rap at the same time as the core is twisted from the plate. When making cores with a very large area on the plate, it is advisable to place a sheet of paper between the core and the plate.

Apart from core-making, oil-sand is invaluable in the jobbing foundry as aids to moulding. In last year's Short Paper Competition Mr. Gill mentioned a few uses to which oil-sand can be put, and one is constantly finding more uses in this direction. Any casting that is "bottom-run" should have an oil-sand runner block. The saving in time and trouble makes ample compensation for the cost of the cores, while the "safety" of the runner is outstanding. Since adopting this method the author has never had experience of a faulty casting, or even a slight defect on a casting, due to a runner washing. No special patterns or core-boxes are needed for the runner cores. A block of oil-sand is taken and the runner filed in to the size required, and a thin cake of oil-sand is gummed on top. The face of a press tool casting had to be perfect, as it was not to be machined. To make this face perfect in green-sand would be practically impossible. The draw of the pattern would undoubtedly break away some of the sharp edges, and mending would be a long and tedious job for the moulder. To ensure a good face a core in oil-sand was made from the pattern. When the core was dry it was fitted on to the pattern and rammed up in the mould. The resultant casting had a perfect face. The actual costs of this instance cannot be compared, as only the one casting was required, but there was undoubtedly a very large saving in time of moulding. Also, under this method, the moulder was working under conditions of absolute safety. Consider making the casting in green-sand. The casting weighs 25 cwts., and the metal thickness is about 5 in. all over. The mould would need to be well rammed to prevent swelling. It would require particular care in venting and mending to keep a true contour and prevent scabbing and blowing. The oil-sand core, which took about 1 cwt. of sand and ¾ hr. time, was definitely safe, as oil-sand does not swell, scab or blow. On drawing the pattern the core is sufficiently hard to prevent any breakage, and mending, sprigging, venting and sleeking are entirely eliminated.

Do you make boiler bars for circular boilers, and have you ever received orders for standard size boiler bars to pattern? The author has seen scores of these castings made, but has never known it possible to find a pattern to the exact size required, although he possesses a range of so-called standard patterns. What is the procedure in making these bars? The nearest sized pattern is obtained and rammed up, then if the pattern is too large the correct size is scribed on to the joint of the mould, and there is the process of cutting off the cods and stopping off a portion of the mould. If the pattern is too small, the reverse has to be done and the cods lengthened by pieces of core, generally made from the pattern. A method recently developed was to make a strickle of the section of the bars, and spindle-mould a plate to the diameter of the bars required. A set of cores was then made in sea-sand and set in the mould. The flat top was tried on to assure a good touch. The bars were split by means of tins coated with oil-sand. Stopping off or cutting out was eliminated, venting and spigging the cods were dispensed with, whilst the risk of cods washing or blowing was minimised.

For round cores up to 2½ in. dia. a "sausage machine" is used, and the red mixture previously mentioned is very satisfactory for this type of machine. When large round cores are required, or valve body cores, and no core-box is available, the cores are made in halves on flat plates, and strickled in the ordinary way. The all sea-sand mixture is quite good for these cores.

Sea-sand cores are very porous, and venting is very rarely required. Valve body cores, having three or four large core-prints, are never vented. Where cores have a very small print area, as compared to the main body of the core, it is advisable to scratch a vent in the half core before jointing. A core for a small condenser casting has a 2½-in. dia. core enclosed in the casting, with the exception of 3½-in. and 2⅝-in. core prints. In 1914 Mr. Pulsford said:—"No venting is necessary. Coke breeze, hay, etc., and all the ramifications a core-maker needs to make a good job are dispensed with. The time to iron weak parts, the difficulty of ramming round these, and the cost of the irons may be eliminated from much of the work in the core-shop by the adoption of oil-sand cores."

Drying.

It is not essential to build special stoves to bake oil-sand cores. If one possesses the latest types, all the better, but if not bake the cores in the stoves used for ordinary core drying. If it can reach 500 deg. the cores will bake hard and good in fairly quick time. The needs of customers to a jobbing foundry make it somewhat difficult to have any fixed routine of work in the coreshop, but where possible work a day or two in advance of the moulders. The author uses two medium stoves to bake cores that are required to be made the same day as ordered. A large stove is filled during the day, and the last thing at night the fire is lit. Experience has indicated the correct amount of coke for the fire thoroughly to heat up the stove. The stove is gradually heated up and the fire then dies out. The result is that the next morning sees a quantity of perfectly-baked cores, sufficient to supply the whole foundry for a day, with the minimum of cost and trouble.

This method of baking is undoubtedly the most satisfactory so far encountered. Many foundries place the green cores directly into an oven at a temperature of between 400 and 500 deg. Fah., but there are disadvantages in this method. The action of this intense heat on a green core appears quickly to bake the skin of the core, and unless the coremaker makes provision for the escape of the steam from the centre, he will find that the force of the escaping steam will crack the hardened skin of the core. When one is obliged to use this quick drying method perforated core-plates are used to allow some exit for the steam, and vent the core face. These vents, however, have to be filled up, and therefore one only employs rapid drying when essential. Also, cores of varying thicknesses will be burnt in one part while another part is still green.

For the mass production of motor casting cores in the foundry of the Oakland Motor Car Company, U.S.A., their cores are dried in continuous stoves built in the formation of towers. The cores are placed into the stove at 100 deg. Fah., and are gradually warmed up to 475 deg. Fah. This temperature is maintained for some time while the core trays travel across the top of the tower, and then as the cores descend the temperature is reducing until they reach the floor level at 145 deg. Fah. This highly mechanical stove arrangement gives the same principle of baking, as the simple method outlined of lighting the fire at night and leaving the cores to be gradually heated up and cooled during the night.

Costs.

Oil-sand cores are vastly cheaper than natural-bonded cores. Below is a survey of a comparison of costs on valve cores of the various types dealt with.

Sand.—For 1 cwt. of mixed sea-sand the material costs are sand 9d., and sufficient oil 6d., making a total cost of materials for 1 cwt. of sand to be 1s. 3d. The material cost of natural-bonded sand is red sand 3d., floor sand nil, and manure nil. Showing that the material cost is much higher when using sea-sand.

Mixing.—The time for placing 1 cwt. of sea-sand and the oil into the mill and out again occupies 5 minutes. Collecting red sand, floor sand and manure, and milling occupies 10 minutes, showing a 50 per cent. saving in the favour of oil-sand.

Irons.—Most valve cores in natural-bonded sand would require a cast core iron, that has to be made and broken to get it out of the casting when fettled. This makes a constant heavy cost on production. These irons are dispensed with in sea-sand cores. Very weak parts are reinforced with a piece of wrought iron. 1 cwt. of ¼-in. round iron, costing 12s., will make enough core irons to last for years.

Production.—Cores are produced by semi-skilled labour at least three times cheaper than ordinary cores with skilled labour. Sea-sand cores are tucked much quicker than ramming ordinary sand, and venting is eliminated.

(*Continued on p.* 266.)

6 F.T.J., June, 1914, p. 371.

The Photomicrography and Metallography of Graphite Flakes.*

By A. L. Norbury, D.Sc., and L. W. Bolton.

Effect of Variations in Methods of Polishing and Photographing on Apparent Size of Graphite Flakes.

The size and distribution of the graphite flakes is recognised to be one of the most important factors governing the mechanical strength and physical properties of a grey cast iron. It is consequently especially important that photomicrographs of graphite structures should show the true size of the flakes, and not represent them as larger or smaller than they really are. This, however, is often by no means an easy matter, since, as Gresty,[1] Logan[2] and others have pointed out, the polishing operation often rounds off the edges of the metal bounding the graphite flakes and thereby makes them appear larger, Burnish polishing, on the other hand, tends to bridge the flakes over and in some cases completely obscures them. The focussing and lighting of the specimen during photography also have a marked effect on the apparent size of the flakes.

The accompanying photomicrographs have been taken to illustrate the wide variations in the apparent size of the same graphite flakes that may result from variations in the technique of polishing and photomicrography. Figs. 1, 2, 3 and 4, 5, 6 are photomicrographs of the same area in a grey cast iron.[3]

The specimen was polished on a rotating selvyt pad using rouge and water. Figs. 1, 2 and 3 show the specimen slightly burnished by polishing on a rather dry pad, photographed at three different focusses: Fig 1 too far away, Fig. 2 correct, Fig. 3 too near.

Figs. 4, 5 and 6 show the same area after repolishing with a copious supply of rouge and water, again taken at approximately the same three differing focusses. It will be seen that the graphite flakes have been considerably opened out by this polishing, and the effect of focus is again marked. (At higher magnifications the effect of focus is usually negligible.) The true graphite size would be slightly larger than that shown by Fig. 2. Generally speaking, it may be stated that for a given specimen the smaller the appearance of the graphite flakes in the photograph the better the technique providing there is no burnishing.

Burnishing occurs most readily when the flakes are thin and consequently more easily bridged over, and when they are bounded by soft low-silicon ferrite. Moreover, those flakes which lie at right angles to the direction of polishing are burnished over more readily. The flakes in the specimen shown in Figs. 1—6 were embedded in pearlite and were not appreciably burnished over, even on a very dry pad. In Figs. 4, 5 and 6 the polishing operation has uncovered a flake lying in the same plane as the surface of the specimen. The presence of some white spots will be noted in this flake. The microstructure of such a flake is dealt with more fully later, and shown at a higher magnification in Fig. 9.

Fig. 7, taken at 500 diameters, shows a specimen[4] containing fine graphite in ferrite which has been burnished by polishing on a pad which was purposely kept too dry. Fig. 8 is the same area after etching in picric acid, showing the removal of the burnished layer by etching, and the uncovering of many graphite flakes previously burnished over by the polishing operation. Incorrect illumination of the specimen during photography, combined with incorrect focus, gives relief effects, making the graphite flakes appear in some cases as if they were raised above the general surface of the specimen, and in other cases as if they were sunk below the surface.

Impurities in Graphite Flakes.

The question of impurities in graphite flakes and the manner in which they occur is also an important one, since impurities might further weaken the iron by increasing the size of the graphite flakes, or alternatively might strengthen the iron if they formed a strong network in each flake attached to the surrounding matrix. Bolton[5] and Diller[6] have published photomicrographs purporting to show ferrite networks inside graphite flakes. The authors are, however, of the opinion that the network structures shown are not real, but are caused by an optical effect due to focussing on a cavity containing the fractured remnants of a graphite flake. The photomicrograph of such a cavity is shown in Fig. 9, in which the apparent network or duplex structure is not real, but is due to the above cause. In some places the ferritic matrix underneath may be seen showing through the remnants of the graphite flake.

It is difficult to polish the graphite flakes in grey iron so that the surfaces of the flakes are flat and undamaged. This is especially the case

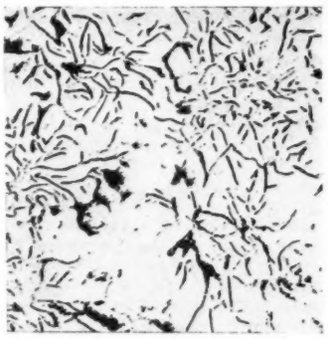


Fig. 1.—× 50.

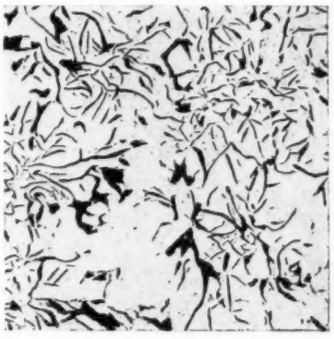


Fig. 2.—× 50.

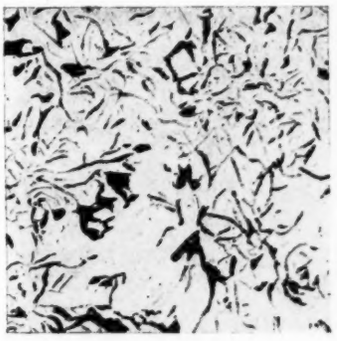


Fig. 3.—× 50.

Graphite Structure polished on rather dry Rouge Pad, showing Slight Burnish and Effect of Focussing: Fig. 1, too far away; Fig. 2, correct; and Fig. 3, too near.

Fig. 4.—× 50.

Fig. 5.—× 50.

Fig. 6.—× 50.

Same Area repolished on Wet Pad, showing Graphite Flakes opened out. Three Focusses as above.

* Extracted by permission from the Bulletin of the B.C.I.R.A.

1 Gresty: Foundry Trade Journal, April 5, 1923.

2 Logan: Foundry Trade Journal, February 19, 1925.

3 The iron contained: T.C. 3.49 per cent., C.C. 0.67 per cent., G.C. 2.82 per cent., Si 1.98 per cent., Mn 0.96 per cent., P 0.72 per cent., S 0.03 per cent., and was sand-cast in the form of a 1.2 in. dia. bar.

4 The specimen was cut from a bath casting containing: T.C. 3.31, C.C. 0.67, G.C. 2.64, Si 2.03, Mn 0.66, S 0.10 P 0.76 per cent.

5 Bolton: "The Foundry," June 1, 1922, p. 436.

6 Diller: "The Foundry," September 1, 1922, p. 704.

with broad flakes, which are more liable to fracture and erosion by the polishing medium. The polishing is best carried out by using a rather dry pad and not rotating the specimen, since the flakes running at right angles to the direction of polishing are less liable to be damaged and eaten away. A graphite flake polished in this way is shown in Fig. 10. On visual examination it could be seen that the surface of the flake was flat and practically undamaged; such flakes show no network structure, but only the faint striations typical of graphite.

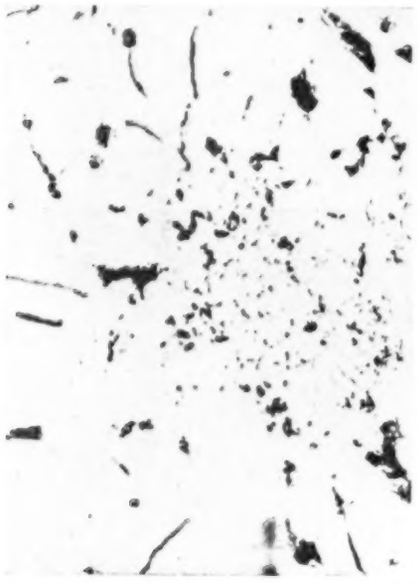


Fig. 7.—× 500. Graphite Flakes covered over by Polishing on too-dry Pad.

Fig. 8.—× 500. Same Area showing Graphite Flakes uncovered and Burnished Layer removed by Etching in Picric Acid.

The flakes shown in Figs. 9 and 10 were photographed after the same polishing operation and lay close together in a specimen cut from a grey iron ingot mould.[7]

The authors have, however, been able to prove the presence of considerable amounts of ferrite in graphite flakes by chemical analysis in the following manner. A certain specimen[8] contained a blowhole about ½ in. in diameter. The walls of the blowhole were covered with kish-like shiny graphite flakes, which were not detached by knocking the specimen about (*e.g.*, the specimen had been broken in tensile), but could be brushed off with a camel-hair brush. About 0.1 gm. of these flakes was collected and on ignition left a residue of iron oxide. Flakes brushed from a similar blowhole in another specimen of somewhat similar composition also yielded an iron oxide residue. The iron contents of the graphite flakes from these two specimens worked out at the following surprisingly large figures:—Graphite flakes from the first specimen contained 37 per cent. Fe and graphite flakes from the second specimen contained 30 per cent. Fe. No silicon could be detected in the iron oxide residue.

Fig. 9.—× 600. Cavity containing fractured Remnants of Graphite Flake. Apparent "Network" Structure.

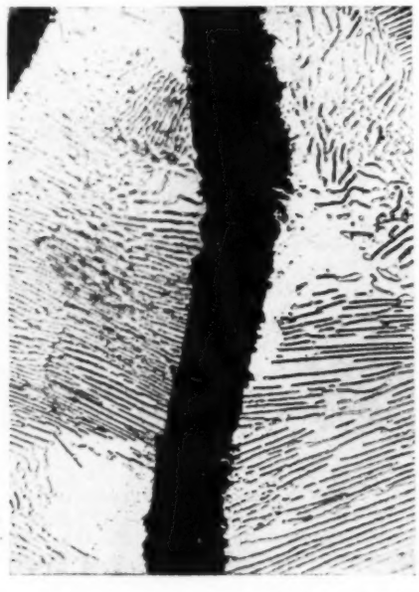


Fig. 10.—× 600. Graphite Flake with Surface polished flat. No "Network" Structure.

The presence of impurities other than ferrite in graphite flakes has also been observed. Pinsl[9] shows photomicrographs of graphite flakes containing considerable amounts of iron phosphide, which he suggests have been sucked up by the porous graphite. Bolton[10] states "sulphur in the sulphide form actually occurs in the graphite flakes . . . probably occurring as mechanical nuclei and finely divided." The evidence of the presence of sulphides was obtained by treating a polished specimen with 2 per cent. phosphoric acid, placing it under the microscope, and observing that bubbles of gas which smelt like hydrogen sulphide rose from the graphite flakes only.

It may, however, be pointed out that gas bubbles would tend to form on the sharp edges bounding the graphite flakes. Furthermore, crystals of sulphide touching porous graphite flakes (as they often do) would give the same effect.

Summary.

Photomicrographs of graphite flakes may represent the flakes as larger than their true size if the methods of polishing and focussing are incorrect. Burnish polishing, on the other hand, may make some flakes too small and actually cover over others. The presence of "ferrite networks" in photomicrographs of graphite flakes is not confirmed, and is shown to be due to focussing on cavities containing the remnants of graphite flakes. It has been shown by chemical analysis that certain flakes contained 30 per cent. to 37 per cent. of their weight of iron.

Oil-Sand Cores in the Small Jobbing Foundry.

(*Continued from p.* 264.)

Fettling.—Fettling is improved considerably with sea-sand cores. Cores run freely from the castings. One labourer can remove all cores and irons from three dozen valve-body castings, weighing about ½ cwt. each, in about ¾ hr.

Core Breakages.—Oil-sand cores are very strong. Breakages are rare occurrences.

Waster Castings.—Waster percentage is considerably reduced when using oil-sand. Oil-sand cores neither scab nor blow.

From actual costs taken over two definite periods, the material costs are £70 higher with oil-sand than with natural-bonded sand. The definite saving in labour, irons and waster castings, etc., is £450, leaving a net saving of £380, which is equivalent to 9d. per cwt. of castings produced.

Conclusion.

In conclusion the author wishes to acknowledge the assistance received from Papers by Messrs. C. W. H. Holmes, H. M. Lane, W. T. Evans, W. West, F. Gill, F. O. Pulsford, J. McEachen and Professor Campion, and to thank Mr. Stevenson for the assistance he has given in preparing the Paper and in allowing the author to use his works for purposes of the Paper.

An order for the construction of twenty Pacific-type locomotives for the Central Argentine Railway has been received recently by Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, Scotswood Works, Newcastle-upon-Tyne. The company has also secured an order for a new oil tanker, making the sixth vessel booked by the firm for Norwegian owners during the past few months.

7 Containing T.C. 3.50 per cent., C.C. 0.85 per cent., G.C. 2.66 per cent., Si 1.16 per cent., Mn 0.40 per cent., S 0.10 per cent., P 0.34 per cent.

8 Containing T.C. 3.78 per cent., C.C. 0.05 per cent., G.C. 3.73 per cent., Si 3.27 per cent., Mn 0.35 per cent., S 0.03 per cent., P 0.03 per cent., cast in sand to give a 1.2-in. dia. bar.

9 Pinsl: "Stahl und Eisen," April 12, 1928, p. 473.

10 Bolton: "The Foundry," June 1, 1922, p. 436.

Modern Industrial Management.

MR. GARDOM'S ADDRESS TO LONDON FOUNDRYMEN.

The first meeting of the session was held at the Engineers' Club, Coventry Street, W.1, on September 26, 1929, when Mr. J. W. Gardom, the new Branch-President, delivered his presidential address.

The retiring Branch-President (Mr. W. B. Lake), who has occupied the office of Branch-President for two years, was in the chair at the commencement of the proceedings. Among the visitors present, to whom he offered a very hearty welcome, were M. E. Ronceray (of France), to whom he referred as one known throughout the world as a most eminent foundryman; and Mr. H. Winterton (the President of the Scottish Branch of the Institute).

The Chairman recalled that in June of this year the London Branch of the Institute had had the honour of entertaining in London the third International Convention of Foundrymen. The members were all aware how very well the proceedings had been conducted, and how impressed the visitors, and particularly the American visitors, had been by the fine show put up by the City of London, and the reception by the Lord Mayor (the Rt. Hon. Sir Kynaston Studd) at the Guildhall. The members of the Branch could claim justifiably that the Convention had been very successful. The credit, of course, was due nominally to the Executive Committee responsible for making the arrangements, and which was formed of members of the London Branch, but, as a matter of fact, practically the whole of the work was done by one man—the hon. secretary and treasurer, Mr. H. G. Sommerfield. (Applause.) It was due to his influence that the Lord Mayor had consented to the use of the Guildhall for the Convention, and had received the visitors in person; indeed, Mr. Sommerfield had been responsible for practically all the arrangements made. Mr. V. C. Faulkner (Past-President of the Institute and of the Branch) had also rendered great service, and it was through his influence that Sir Hugo Hirst had entertained our American friends on their arrival. Altogether, it could safely be left to the General Council of the Institute to say that the London Branch had done the work which was asked of it. The accounts had not yet been audited, so that nothing definite could be said with regard to the finances, but he believed Mr. Sommerfield had managed the business so carefully that neither the Institute nor the London Branch would be called upon to put their hands into their pockets, except for amounts already agreed upon. That was a very wonderful result.

The Chairman moved a very hearty vote of thanks to Mr. Sommerfield for the great work he had done in connection with the Convention and the Foundry Exhibition held concurrently with it.

Mr. A. W. G. Bagshawe seconded.

The vote of thanks was carried with acclamation.

Mr. Sommerfield briefly responded.

Vote of Thanks to the Retiring Branch-President.

Mr. Wesley Lambert (President of the Institute), proposing a very hearty vote of thanks to Mr. Lake for his services as Branch-President during the past two years, said the members of the Branch had enjoyed a most harmonious period under his leadership. They had known, when he had been elected to the presidential chair, that he was a gentleman, and his attitude during his period of office had proved—if proof were necessary—that he was a gentleman in every respect. Their grief in parting with Mr. Lake as Branch-President was softened by the knowledge that his successor, Mr. Gardom, was a man of such great tact and who had such a great interest in the London Branch.

The President also took the opportunity to thank all his colleagues of the London Branch—for he belongs to the Branch—for their great efforts to make the London Convention a success. His duties during that Convention had been made quite easy for him, and he had enjoyed thoroughly every minute of it. That could not have been the case had not the organisation been perfect. The results also were perfect, and he was delighted that a vote of thanks had been accorded Mr. Sommerfield for the great part he had played, because it was his (the President's) intention to see that that was done at the first opportunity.

Mr. John Shaw, seconding the vote of thanks to Mr. Lake, said that not only was he a man of great practical experience, but he had conducted the affairs of the Branch with tact and geniality. Having achieved success in his own work, he was in a position to judge of the value of the various Papers presented to the Branch, and his conduct of the meetings generally had added to the pleasure derived from them.

The vote of thanks was carried with acclamation.

Mr. Lake, responding, said he had enjoyed thoroughly his period of office as Branch-President. During that period he had made many new friends, and had renewed his acquaintance with many old ones. Further, the holding of the office was an education, and he had learned a great deal as the result of it. Any success he might have achieved was due to the unfailing support and loyalty of the officers and members of the Branch generally, and he took the opportunity to thank them heartily for it.

Induction of New Branch-President.

Mr. Lake then introduced Mr. J. W. Gardom (of Dunstable), the new Branch-President, and expressed the confidence which was shared by all the members that he would make an ideal President. He had been assiduous in his attendance at the meetings of the Branch, and had rendered great help as a member of Council; further, he had presented some very valuable Papers, and he could rest assured that the members of the Branch would do all in their power to make his year of office happy and successful.

Modern Industrial Management.

Mr. Gardom then formally occupied the chair, and, after expressing his thanks for the tribute paid to him, and his confidence that the members would help him to make his period of office a success, he read his Presidential Address, in the course of which he said:—

Mr. Lake and Gentlemen,—The "Houghton Line" some time ago published the following: "One man manufactured something which the people really needed and he made a living; another manufactured efficiently something which the people did not need, but caused them to want it by skilful advertising and he made a fortune. He will also get a monument." Can this be really true, and, if so, was the monument deserved?

We still have in this country works making profits because their productions have special advantages demanding prices which leave large margins for profit, but such firms are exceptional. There are other works making a profit because all the materials required are bought in the best (not necessarily the cheapest) markets. Production is efficiently carried out by satisfied workpeople, and constant new markets are found by up-to-date salesmen and a live selling organisation. Such firms also are few and far between, and between these two extremes are all sorts and conditions of struggling works, many only just keeping their heads above water. I have always considered (although I may be wrong) that a foundry existed in business for the purpose of making money for those engaged in that business. How then can a foundry not producing an article having the special advantages previously referred to make a profit? *Simply by good management.*

Management Defined.

Management, then, can be defined as the art of making more and more net profits. Every works, however small, has someone carrying the title of manager, but how have these men obtained such positions and what are their special qualifications? We so often hear the foundry referred to as the Cinderella of the engineering trade, but what of the management? To-day industrial management is unorganised, with no qualification to indicate the suitability of an applicant for a post. Yet management is the co-ordinating function, surrounded by all professions, scientists and technicians, not one without their qualifications for entry and examinations of proficiency. The true aim of management is to make a profit, but in obtaining this many qualities are necessary. The "big stick" method has now been entirely eliminated, and more and more fully is it becoming recognised that a "give and take" policy and "the square deal" are the only sure ways to success.

Our foundries and works are becoming more and more mechanised, but with each step in this direction it becomes more and more necessary for the good manager to understand human nature, because success or failure is governed by the human effort. People do not work well for a man they dislike and who repels friendliness by his lack of sympathy and cheerfulness. Once the confidence and goodwill of the employees is obtained a good daily output is assured, but do not think this is to be obtained by flowing speeches or carefully-worded notices. Remember our workmen have suffered much in the past from ill-advised methods of wage-cutting, lack of helpful supervision and sharp practice.

A manager must be interested in his people, their opinions and difficulties; they must be treated courteously as members of the company, and once they know he is truly interested in them, production will be increased. A manager has a difficult task; he is constantly misunderstood, both by those above and those below. Few people realising the difficulties and responsibilities. Too often his own family does not, *but* has such a man the right to consider he is bearing a burden greater than the father of a large family faced with imminent unemployment?

Regarding the actual routine of management much has been written. In this country, particularly, the system has followed the growth of the firm with additions from time to time. If the owners of the business had when they started been fully aware to what extent and at what rate it would develop, then no doubt a more suitable system would have been employed. It is difficult and often undesirable for a new manager so to reorganise a system that many of the old employees, who have grown up with that business and helped to its development, should be disturbed. Competition, however, demands that efficient production be obtained, and no doubt in many cases the transfer to "Pension Salaries" of some of the personnel would both solve the problem and lessen expense.

The secret of successful management will be found to live in the limited but definite transfer of authority and responsibility. So often do we hear it is impossible to find men suitable for holding responsible posts, but whilst we have managers endeavouring to carry all responsibility and unwilling to hand to their assistants authority to carry out any definite duties of works control or procedure, how can such faculties be developed? This, however, means that time must be given to the control and regula-

tion of subordinates, yet so often is the manager's time fully engaged on routine work that no time can be given to thought of work arrangement and re-arrangement. In such cases foremen and others waste hours because they cannot get the ear of the manager, who, above all others, should be free to consult and not have as a slogan: "If you want a thing done you must do it yourself." Such a man is not a manager, and it is for this reason that so many good workmen are unable to control others, he is always busy but he does not teach.

A Primary Duty.

Teaching is the first duty of management. There is one best way of doing everything, this method must be carefully thought out by the manager—the employees seldom discover it, they must be taught and trained. Referring again to routine, no two works can be run by the same system in detail, and particularly in this country it is necessary carefully to consider all conditions and build up a system of control which not only issues orders but is assured of these orders being carried out. Careful planning of the whole progress of individual parts necessary to make the whole is essential, so that the parts come together at the required time. So often do we see heavy castings rushed through the foundry to the machine shop only to be held up awaiting the arrival of lifting tackle from some other department to allow the work to be placed on the machine. Or a complete conveying system held up for the arrival of the necessary gearing or electric drive.

Scientific Management.

To America, as in many other things, we are indebted for a real endeavour to place management on a firm basis and, following the pioneer F. W. Taylor, many workers, including the Gilbreths, Hubbard, Gantt and Emerson, have placed their writings, with which no doubt you are familiar, and their experimental methods freely before us, the results being known as "Scientific Management." Science rests upon a large number of facts, carefully collected over long periods and classified. These classifications, after repeated confirmations, are termed hypotheses. But the scientist, being a man of integrity, still does not consider his laws or principles proved but continues to test and verify the possibility of error in accepted truths until a theory is formed, and upon these facts progress is made from understanding. So Taylor studied the correct sequence of carrying out the detailed operations for the whole, and Gilbreth, by motion study, decided the quickest means, with the least waste or fatigue, to carry out any operation. From these methods surprising results have been achieved in America, the daily output per man in many cases having been doubled.

Orderliness Essential to Economic Production.

Applied to our own industry, it means that the moulding methods of every workman for a similar job would be identical. All tools would be kept in identical places, and all the necessary operations to produce a mould would be carried out without the slightest variation to the prescribed sequence. These rules of procedure being published by the management and the employee so drilled until this "best way" was automatically carried out. Yet, good as the results have been, I do not know of one foundry in England employing such methods. Why is this? Are we too conservative to be taught or to change our views, or is the scheme impracticable? We are industrially the oldest country in the world, and our present systems have grown by gradual, but certain, improvements through the centuries, with all the problems overcome as they have arisen, each step forward having to overcome, practice handed from father to son.

America, on the other hand, is a new, machine-made and machine-driven, mass-production country, with a very different labour supply from that which exists in England, so that standardisation of methods is comparatively easy, whereas standardisation to our own workmen is distasteful, and in almost every case such men, brought up on the tradition of producing a quality article by their own skill, would prefer an interesting job to the increased wages obtainable working under motion-study direction.

Further, it is doubtful if, with our lower outputs (these being entirely governed by the available markets), sufficient increase could be obtained to pay for the extra overhead cost of the systemisation of scientific management. These methods are naturally more likely to be successful in a country depending upon one home market rather than in the country supplying a hundred and one different needs and conditions.

Limitations of the "Safety First" Slogan.

There may not be room for two mass-production countries, but there certainly is room for quality articles, but if to this quality-article production we can apply some of the principles of mass production, then we are assured of success. The problem of our managers is, therefore, to develop some semi-scientific management which will treat the workman as an intelligent personality, allowing him the maximum self-direction, but constantly guiding and teaching him to conserve his energy, avoid waste in all forms, and increase output to obtain more wages per day. Such an ideal can only be reached by the manager who (1) knows human nature, (2) is fully conversant with scientific principles, and (3) forgets that much-vaunted slogan "Safety First." Excellent as safety-first methods may be in many spheres, they have no place in progress. Our country and our industrial supremacy was built up by taking risks in the spirit of adventure.

I do not suggest the opposite slogan—"Thoughtless Rashness." This is just as foolish as being too careful to avoid it. In the everyday habits of life—crossing or using a road, the careful use of an established machine, or the leaning of a ladder on air—here safety-first applies, for by carelessness you may not only break your own head, but others as well. The youth who takes up the first opening offered or enters the ready-made position of his ancestor without considering his suitability or otherwise is playing a safety-first game of little value to industry.

Progress Retarded by Statistics.

It is often stated that we live in a mechanical age; this is not true. Machinery is our servant, and, wonderful though it may be, we do not shrink from improving and making more intricate those machines which we have been told will become our masters. When a new process is suggested, do not consider and consider until it is too late, but come quickly to a decision. I wonder how many metallurgists have had fruitful schemes nipped in the bud because always before their mind is the wonderful statistical records which daily show a ten- or twenty-pound variation on the scrap output, so safety-first again comes into play, and possible progress is lost.

Modern Salesmanship.

Scientific management has now passed from the factory to other spheres, and is now being applied to salesmanship, and judging by the advertisements one sees a salesman can be discovered and trained in a very short time. I am afraid, however, I am still of the opinion that common to other employment there is only one sure method of success in salesmanship, and this is "Know your job and your man." Good salesmen are essential to our industry, but they certainly would be of greater help if before calling upon a customer they would make themselves familiar with all past complaints and present delivery positions. Essentially, however, the salesman must understand human nature, and as it seems impossible for one man to have the necessary qualities to appeal to all types of buyers, would it not be advisable to have two men of dissimilar natures alternatively calling upon the customers of a district? Should one not be favourably received in one case then the other may be.

Science is based on facts, and has despite stubborn prejudices and prophecies raised itself to the forefront in commerce and industry, so this scientific management which is based on actual experiment and fact should not be cast aside as inapplicable to our peculiar conditions, but should be carefully examined, its theory mastered, and through understanding its advantages instilled into our workpeople.

Striving for an Ideal.

You may consider that I am laying before you ideals that are impossible of attainment, but it is necessary to have some goal to work towards. To fix upon some ideal, almost unattainable, is of great value to the factory manager, and can almost be likened to the theory of the scientist. Suppose you take as an ideal the payment of every moulder £10 per week. Here is something to work for, and no doubt if attained the monument would follow. Our orders are obtained in severe competition, and the most visionary idealist realises that wages are governed by the amount of productive work carried out. It follows, therefore, that to obtain orders, prices and quality must be as good as obtainable in any sphere; however, to meet your ideal, wages must not be lowered but increased. We are also fully aware that human effort is limited, and work beyond the physical endurance of the worker cannot be produced.

The problem then of the manager is to obtain a greater output, the quality remaining the same, without any greater physical effort on the part of the workman. You are all familiar with the many ways this may be arrived at, but to obtain the best way requires thought, probably long and continuous thought, and upon this rests successful management.

Just as the wonderful machines of to-day have been built up by small and succeeding improvements, so the best production methods are only reached after many small but new ideas. The most fruitful source of new ideas is the inspection of other plants. Carlyle said "That man is most original who is able to adapt from the greatest number of sources."

With this in mind I propose during my year of office to support as many "works visits" as possible, and I do not consider that such visits need only be to foundries. Many production details and all management arrangements of factories not even closely allied to the foundry trade may be applied to our own productions, and will possibly be an incentive to improvements. Much of the thought and probably all the sentiment of this address has been aroused by the recent Düsseldorf visit of the B.C.I.R.A.

A Vote of Thanks to the Branch-President.

Mr. A. W. G. Bagshawe, proposing a vote of thanks to the President for his Address, said it would readily be admitted that it was full of ideals, but full of truth; the members would think over it sincerely, and it would do them all good. The President had drawn attention to many pitfalls which must be avoided in management, and the truths he had uttered were well "rammed in"; if the general principles were followed his Address alone would have been sufficient to justify his year of office.

Mr. V. C. Faulkner (Past-President of the Institute), seconding the vote of thanks, recalled that Mr. Gardom was one of the few metallurgists in Great Britain who had graduated from the chemical laboratory to works management—a type of progress usually left to the engineers. It was recognised, he continued, that any Presidential Address must consist of a series of platitudes, and the value of a Presidential Address was ascribed definitely to the manner in

which those platitudes were put forward. The particular phase with which Mr. Gardom had dealt was a very interesting one, because the bulk of the members of the Institute were managers, and he had shown very clearly what the duties of management were. Referring to the recent visit of the B.C.I.R.A. to Germany, Mr. Faulkner expressed the view that the wrong types of persons had taken part in it; the majority of those who had taken part were people with very erudite minds, and who were definitely progressive, whereas the people who ought to have taken part were those who were responsible for the thousands of bogie-holes, called "foundries," which existed throughout Great Britain. Since he had returned from Germany he had visited some of these bogie-holes, and had been asked what he would suggest for their improvement. He had felt that in many cases nothing short of bombing would be of any use, but finally he had crystallised his recommendations and had suggested a method such as had been suggested to him by Mr. Lambert as a means of getting rid of weeds on his lawn. That method, as applied to the lawn, was to mark out the lawn in patches of, say, a square yard, and to weed each in turn, making sure that each was weeded properly before dealing with the next. So each of the "bogie-holes" to which he had referred might be put right by dealing with one small piece at a time. One should examine everything in turn, find out whether it had been used during the last year; whether anything better was available; whether it was likely to be used again, and, if not, consign it to the scrap heap. That was the proper way to deal with a large number of the so-called foundries in Great Britain. It was the necessity for dealing with that state of affairs that Mr. Gardom had so well emphasised in the course of his Presidential Address, and the members were indebted to him for having put forward his views in such a plain and interesting manner.

The vote of thanks was carried with enthusiasm.

The Branch-President briefly responded. He also expressed the hope that in the future Mr. Lake would maintain his interest in the Branch, and would continue to give it the benefit of his assistance. (Hear, hear.)

Increasing the Utility of Technical Meetings.

Following a suggestion by the President, a discussion ensued as to means which might be adopted with a view to improving the working of the Branch so that its activities might be increasingly enjoyable and instructive to the members generally, and so that each might have increasing opportunities of helping his colleagues.

Mr. Wesley Lambert (President of the Institute) urged that the members ought to know each other better than they do at present, and that something should be done to remedy this defect. When a new member was elected and had attended two or three meetings his fellow-members began to know him, *but not sufficiently well*. They ought to be able to learn who he was, where he came from, what his interests were, and so on, so that they would know how they could help him. There might be members who would like to hear a Paper read on some special subject, or who might have experienced certain troubles in the foundry, but, perhaps because they felt they were not sufficiently well known, they did not mention these matters, and members had not the opportunity to help them as they would like to. By ensuring that the members knew each other better the work of the Branch could be made increasingly valuable. It was true that the discussions were good, but too often they were carried on by only a few people, the remainder refraining because they felt they were not sufficiently well known in the Branch.

Mr. John Smeeton, M.I.Mech.E., having in mind the impossibility of remembering the names of all the individuals one met at meetings and in business, and the fact that in many cases the knowledge of a man's name was sufficient to remind one of that man's interests, suggested that at the Branch meetings each member should wear a badge, similar to that worn at the annual Conventions, bearing his name. When one saw a man's name on his badge one might be reminded that one wished to talk to him about an article he had written, or about something else in which he was interested. Therefore the ability to identify one's fellow-members was of great importance. Another suggestion was that the members might be given an opportunity to dine together before each meeting, so that they might have better opportunities for knowing each other intimately. It appeared to him that they lacked the social spirit which was really one of the fundamental features of the Englishman.

Mr. H. G. Sommerfield (Hon. Secretary and Treasurer) pointed out that some of the Branches of the Institute opened each session with a smoking concert, and he asked for an expression of opinion by the members as to whether they would wish to have a similar function arranged also.

(A show of hands indicated that the members were in favour of a smoking concert being arranged, and Mr. Sommerfield indicated that the matter would be considered by the Branch Council.)

Another suggestion put forward by Mr. Sommerfield was that the members might care to contribute a nominal amount each year to a fund which could be used to provide two or three rooms which would serve as a club for them, and could also be used for the meetings. The members of the London Branch did not agitate enough; the Council was often discussing what they could do for the members, and would welcome ideas from them.

Mr. V. C. Faulkner pointed out that those who attended the Branch meetings at the Engineers' Club automatically became members of the Club on the evenings on which the meetings were held; it was the practice of a few of them to dine together at the Club before the meeting, and there was no reason why all the members should not dine together there on such occasions. He felt sure the Club would welcome such a practice, and the few members of the Branch who dined together before each meeting would be happy to see the number of diners increased to 50 or 100. The dinner was good and inexpensive, and he urged members of the Branch to take advantage of the privilege extended to them by the Club.

Mr. A. W. G. Bagshawe commented that most of the discussions on the Papers read at the meetings were maintained by only about a dozen members, each of whom spoke at practically every meeting, and that others would not speak, possibly because they feared they were not competent to do so, or because they were nervous, or for other reasons. Therefore, he suggested that after each Paper was read the Branch-President should call upon one of the members who did not speak regularly to propose a vote of thanks to the author. Once a member got on to his feet he would begin to get into the habit of doing so, and his fellow-members would benefit. The suggestion made by Mr. Smeeton that each member should wear a badge bearing their name was a good one.

Mr. Bagshawe, continuing, also supported the idea to acquire rooms for the use of the members, and said he would be willing to contribute a reasonable amount. Such a scheme should not be costly.

Mr. Faulkner suggested that it might be possible to secure a room at the Engineers' Club for use by members at stated times.

Mr. C. Cleaver suggested that the register of attendance, which was signed by members attending each meeting, should contain a second column, in which latter each individual member could enter the name of his firm. The mention of a member's firm would serve at once to connect him in the minds of his fellow-members.

Mr. W. B. Lake (past Branch-President) expressed himself as being heartily in sympathy with the views expressed as to the necessity for knowing each other better. In supporting the suggestion that each member might wear a badge indicating his name, etc., he said that he belonged to a club the members of which wore such badges at each meeting, each badge bearing the name of the wearer and an indication of the article he was manufacturing or trading in. The badges were hung on a board in the meeting room after each meeting, and each member took his badge from the board at the commencement of each meeting. If each member of the Branch wore a badge indicating his own name and that of his firm, it would be of great advantage, because when one knew the business interests of one's fellow-members, one knew what one could talk about.

The suggestion to form a little club for the members of the Branch appeared to be a little ambitious at first sight, but if it appealed to them he would be happy to support it.

Mr. A. R. Bartlett, supporting the suggestion that each member should wear a badge by which he could be identified, said that ample evidence of the value of such badges had been forthcoming at the Institute's Conventions. He also recalled that about eighteen or twenty years ago it was the practice to introduce each member as he entered the room in which the Branch meetings were held. That method had been successful to a certain extent, but it was not successful as the wearing of a badge.

Mr. E. Ronceray (of France), who was invited to state the methods adopted in France, said that badges for identification purposes were worn by members of the Foundrymen's Association there. One year the badges were numbered, and members were provided with printed lists indicating the name to which each number was allotted. That scheme was not so successful as was the carrying of the names on the badges themselves, however, because it became necessary to refer to the lists before one could identify a fellow-member.

(The meeting then closed, and coffee and sandwiches were provided for the members.)

Trade Improvement in Derby.

Although there has been a decided increase in the number of orders received by Derby engineering and foundry firms during the past few months, those firms specialising in the manufacture of grain elevators are very optimistic that still more work will be found for the employees. A director of Fletcher Malleable Foundries, Limited, informed our representative that news from Canada was of particular interest to at least two local foundry firms that specialise in the manufacture of grain elevators and handling plant of stores. "If the scheme matures," he said, "there is no doubt that a considerable volume of work would come to Derby." He mentioned that his firm made grain elevators and chassis of agricultural machinery, but that freight rates operated against competition with manufacturers in the United States of America. "There are two Derby firms who can employ 1,500 hands, but are only on half capacity," he said. "They could employ 2,500 hands, at least, on full production. If Derby works were fully employed, productive costs would be lowered, and, with a flow of orders assured, prices would compare favourably with those of the U.S.A.

Mr. G. H. Haslam, general manager of Messrs. Haslam & Newton, Limited, who are very much interested in the supply of cold-storage plant, anticipated that if the scheme matured it would present to them a good opportunity to bring the scheme to Derby.

Electricity as a Factor in Foundry Developments.

MR. OXLEY'S ADDRESS TO THE SHEFFIELD BRANCH OF THE I.B.F.

The inaugural meeting of the 1929-30 session of the Sheffield Section was held at the King's Head Hotel, Sheffield, on September 27, when Mr. G. L. Oxley (of George Oxley & Sons, Limited, Vulcan Foundry, Sheffield), the recently-elected president, delivered his presidential address.

Mr. Oxley said he thought it might be of interest to go over some of the developments and improvements which had taken place in the foundry industry during recent years. For centuries there was very little progress in the foundry industry, but in recent years it had claimed a big share of attention from the inventive engineer.

He thought they would all agree that foremost among improvements was the application of electricity to the foundry. This helped in many ways. It had revolutionised lifting, especially in shops manufacturing the heavier classes of castings. The artificial lighting of the foundries to-day was very much better than that of olden days. In the short, dull winter days much time was lost if a shop was not efficiently lighted.

The electric motor, used as a means of driving the cupola fan or blower, had saved the foundryman many an anxious hour in the middle of a melt, owing to its reliability over the old steam-driven contrivances. Electricity was the motive power for most of the moulding machines in the foundry and woodworking machines in the patternshop. The sand-blast plants, sand mills and mixers, along with many other improvements in plant of the modern foundry, looked to electricity for their power, and in many steel foundries it was used as a melting unit. He thought, therefore, that they might put the application of electricity to the foundry as being the most important development.

Cupola Melting still Paramount.

In the iron foundry, inventors had turned their attention to the cupola. During recent years various types of cupolas had appeared on the market, some with specially heated blast, such as the Schürmann cupola, while others claimed to have lowered melting costs by alteration to the tuyeres, such as the Poumay system. The drop-bottom cupola had come into favour, and, while it undoubtedly had its advantages, it had its drawbacks as well—and even on this point there was divided opinion amongst foundrymen. But all these improvements did not fundamentally alter the cupola. To-day it was still the standard melting-unit in the iron foundry and he thought it would continue to be so for many years, unless some method was found of producing electric power much cheaper.

During recent years the foundryman had paid much-needed attention to improvements of the drying stoves, and to-day the modern drying stove was a wonderful improvement over the old flueless stove of days gone by: it was more economical in fuel, and, by keeping a steady heat, dried jobs better and quicker. A good drying stove was within the range of practically every foundryman's pocket, and need not be an expensive and elaborate gas-fired stove. He was sure that money spent on stove improvements was money well spent.

Oil-Sand Cores.

A great deal of attention had been paid latterly to the making of cores, and core oils of all makes and brands had appeared on the market. Sea sand, when mixed with these oils, gave a very strong but porous core, and in many cases needed no irons at all. There was no doubt that oil-sand cores had been a great help to the foundryman who was engaged on the production of light and intricate repetition work.

The introduction of moulding machines had been a great help to many foundries, and here again it was the repetition-work foundries that had reaped the greatest benefit. There were many different makes and types of machine, the most simple being the small hand-operated jolt machines, which were very useful for small work. Then they had the plain jolt machine, and the turnover jolt machine, some worked by pneumatic power and others by electricity. Provided a good make of one of these types of machine was procured and looked after properly they were very reliable.

The sand-slinger was a machine which had come into great prominence lately, and had been found very useful by many foundries. But in all these different types of machine, it was essential for the foundryman to be careful to choose the machine most suitable for his special class of work.

Sand Preparation.

Many foundries to-day were installing special sand-preparing plants. These plants varied greatly. Some of the smaller types were fed by hand, and had a separating machine for dealing with the scrap and sprigs in the sand; then, after going through a mixer, the sand went into a mixing mill, and then into bins for the moulders' use. The larger plants dried the sand, which, on certain classes of work, was undoubtedly a very good thing. After being dried, the sand was moistened to the required amount, and then passed on to the mixer, and from there to the mill for the required amount of grinding. From the mill, conveyor belts or other similar apparatus carried the sand to the hoppers above the moulding machine, from which, at the movement of a lever, the sand was shot down into the moulding boxes on the machines.

These large sand-handling plants were beyond the pocket of many of the medium-sized foundries, and he very much doubted whether they were really worth the expense of their outlay, unless a foundry was fortunate enough to obtain sufficient work to run constantly at full output, and thus was able to pay the heavy overhead charges on these big plants.

Metallurgical Improvements.

In the metallurgy of steel and iron in the foundry they found big improvements. Crucible and electric furnaces were now producing stainless and alloy steels, and castings which were not dreamed of thirty years ago. The cupola was also producing special mixtures of iron, and, given a good furnace well handled, it was surprising what accurate results could be obtained.

Semi-steel, which all of them in the foundry industry had heard so much about during the last few years, had certainly come to stay, and for certain classes of castings there was no doubt it had many advantages, allowing the foundryman to get a very tough iron and yet one that was easily machinable.

Pearlitic iron had also come to the fore lately, and, although it was a very fine iron, it was not an easy thing to attain for the jobbing founder, who often had four or five different mixtures to get out of his cupola in the course of a day's blow.

Nitrating Chilled Rolls.

One of the latest developments of cast iron was the nitrating process of chrome-vanadium iron for hardening the working surfaces. This process was, he believed, being successfully used on the hardening of motor cylinders. This was done after the castings had been machined and ground up to size. He could foresee that, if this process was developed, it might revolutionise the making of chilled rolls, as the rolls could be cast in this chrome-vanadium iron, machined up, and then hardened by the nitrating process, which, if it could be adopted, would undoubtedly cut out a lot of waste in chill-roll making.

In all these improvements they must not forget the improvement of the human element. By this he meant the skill of their moulders, who had had to make all the intricate and complicated castings demanded of the foundry industry during the advance of modern engineering. The British moulder was the most skilful of his class in the world—they hoped that he might long hold that supremacy.

There were many more improvements in store for the industry in the years to come. Of that he was sure, but he would not like to prophesy what they would be. Of this, however, he could assure them all that, by being members of the I.B.F., they would be amongst the foremost to hear of those improvements as they came along.

Mr. Oxley concluded with a reference to the Section's programme for the session. He said the Council had arranged a very interesting set of lectures, two of which were joint lectures with kindred societies. He asked all the members to make a special note of the dates of all the meetings, and make a point of attending them.

Vote of Thanks.

Mr. Ambrose Firth proposed a hearty vote of thanks to Mr. Oxley for his most interesting address, and wished him a very successful year as President of the Section.

The Hon. J. M. W. North, in seconding, said there was no doubt that a tremendous amount of progress had been made in the foundry lately, and it would increase as time went on. Whatever they did to improve their foundry, whether by putting in new machines or altering existing machinery in order to speed up production and bring about more economical working, it was essential that they should have good organisation. They had seen cases of very expensive machines which had been bought and had been absolute failures, but he thought it was generally bad organisation that had accounted for the failure. There were good machines, and there were bad machines, but, whatever they had, they had to organise the work in order to give the machines a chance, and not to expect the machines to do all the work. Electricity had played a very big part in foundry development, but second to that he thought they must put the oil-sand core, which had helped moulders out of a multitude of difficulties, and would continue to help them wherever it was applied intelligently.

The vote was carried amid applause.

The remainder of the evening was devoted to a smoking concert. The artistes were Miss Elsa Cooke (contralto), Mr. Arthur Lawson (baritone), Mr. W. J. Parker (songs at the piano), and three members of the Minerva Four from the Sheffield Hippodrome (musical and dancing speciality).

Contracts Open.

Llanelly, October 16.—Sluice valves and ironwork, for the Corporation. Mr. G. Watkeys, borough engineer, Town Hall, Llanelly.

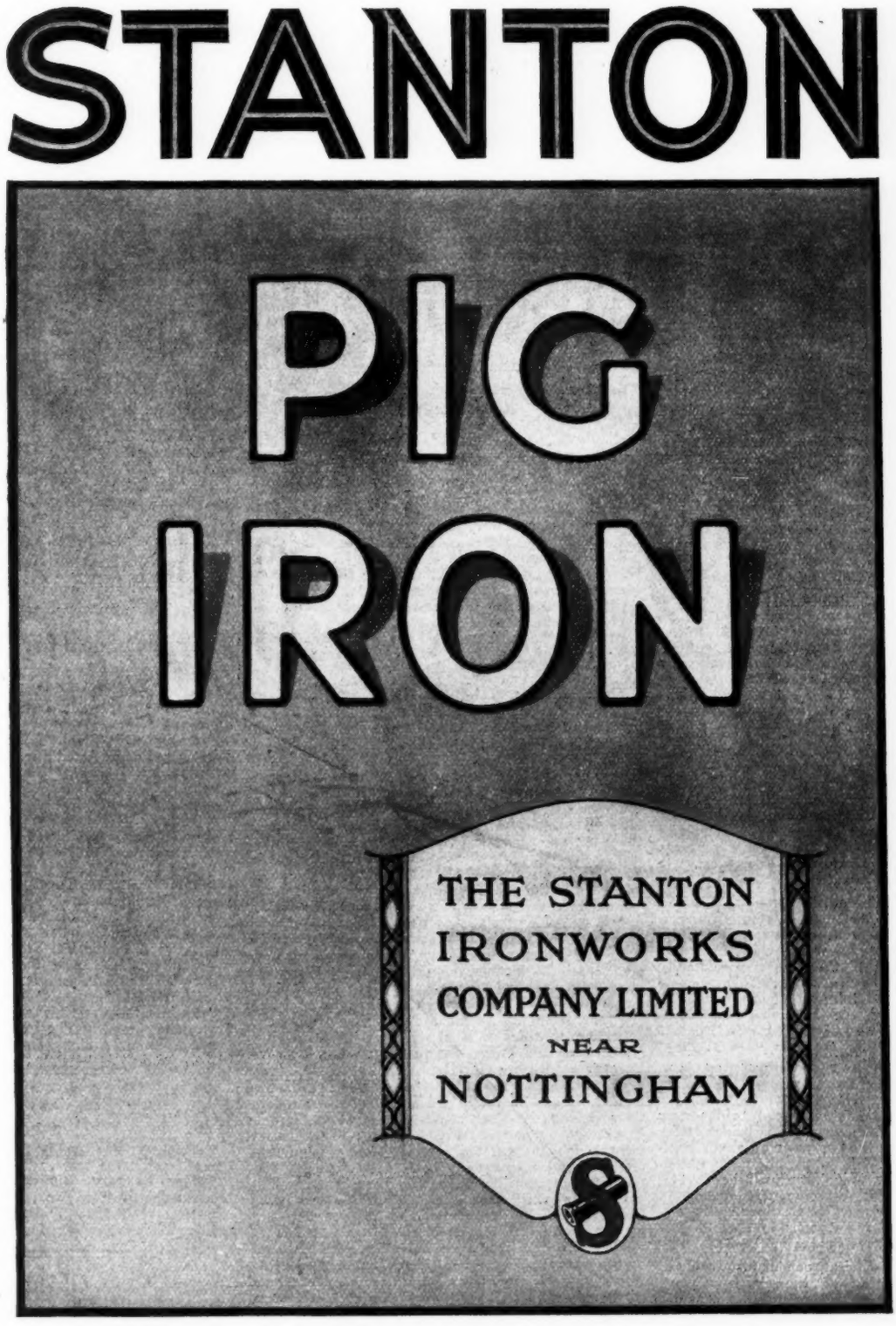
Cairo, November 25.—Two Diesel pumping units, for the Ministry of Public Works, Cairo. The Chief Inspecting Engineer, Egyptian Government, 41, Tothill Street, S.W. (Fee £1 0s. 6d., non-returnable.)

Kafr-el-Dawar, Egypt, December 3.—Swing bridge, for the Egyptian Government. The Department of Overseas Trade. (Reference A.X. 8,562.)

Mangabad, Egypt, November 2.—Swing bridge, for the Egyptian Government. The Department of Overseas Trade. (Reference A.X. 8,561.)

New Delhi, India, November 8.—Ram pumps, steel piping, etc., for the Indian Stores Department. The Department of Overseas Trade. (Reference A.X. 8,594.)

Pentre, October 21.—20-ton automatic weighbridge, for the Rhondda Urban District Council. Mr. M. Bowman, electrical engineer, Electricity Works, Porth, Glamorgan.


STANTON
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THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Trade Talk.

Old steel rails are being used as signal posts on the Southern Railway system.

Mr. Richard Lowndes, secretary of the Midland Iron and Steel Wages Board, announces that wages are to be advanced 2½ per cent. as from October 7.

The dispute at the Reddish engineering works of Messrs. Craven Bros. (Manchester), Limited, which affected over 400 men, lasted only one day, the men agreeing unconditionally to return to work.

Messrs. Norman Hope & Partners, 61, Wind Street, Swansea, have been appointed by Messrs. James Gordon & Company, Limited, combustion engineers, Windsor House, Kingsway, London, W.C., as their representatives in South Wales.

Messrs. Sir William Arrol & Company, Limited, Bridgeton, Glasgow, have secured a contract from the London Power Company, who are carrying out big extensions to the East Deptford power station, which will entail a good deal of constructional steel work.

The Geological Research Department, which has been carrying out investigations in the Isle of Orkney, has recently discovered lodes of hematite in some parts of the Island of Hoy. The ore is reported to be very rich and containing a high percentage of iron.

At a recent meeting of the Falkirk Dean of Guild a petition by the Falkirk Iron Company, Limited, to make alterations and extensions to their enamel melting shop was granted. The alterations include the raising of the existing walls and the erection of a new steel roof.

It is reported that steel orders valued at £6,000 have been secured by Messrs. John Williams & Sons (Cardiff), Limited. One of the orders is for 40,000 sq. ft. of steel partitioning for a new artificial silk factory near Derby, and the other for 15,000 sq. ft. of the same product for a Glasgow company.

Messrs. Galloways, Limited, Knott Mill Iron Works, Manchester, have recently booked a further order for their patent supermiser to work in conjunction with an existing Lancashire boiler battery. The supermiser will deal with a normal evaporation of 83,000 lbs. of water per hr., this being the largest single unit yet supplied. There are now in service or on order twelve units, dealing with a total normal evaporation of 500,000 lbs. per hr.

An order for the hulls of three twin-screw motor oil tankers has been placed with the Caledon Shipbuilding & Engineering Company, Limited, Dundee, by Aktiebolaget Gotaverken, shipbuilders, of Gothenburg, Sweden. On completion the hulls will be towed to Sweden, to be engined by Aktiebolaget Gotaverken. The vessels are for a new company, Rederaktiebolaget Alse, of Malmo. Each vessel will be capable of carrying about 11,500 tons.

Messrs. John A. Smeeton, Limited, of 15, Victoria Street, London, S.W.1, have appointed Messrs. H. J. & J. E. Richardson, engineers, of "Binstead," Ashton-on-Mersey, near Manchester, as subagents for the Lancashire, Cheshire and Flintshire districts, to represent the firm's interests in the sale and exploitation of the foundry plant and equipment manufactured by the Badische Maschinenfabrik of Durlach, and also of the "Collin" patent foundry ladles.

The Crown Agents for the Colonies have awarded a contract to Messrs. P. & W. MacLellan, Limited, Clytha Works, Glasgow, for the steelwork of a new combined railway and road bridge over the Nile at Jinja, Lake Victoria. The bridge is for the purpose of carrying the Kenya and Uganda Railway over the Victoria Nile to permit of its extension to Kampala. The main span will be 260 ft. long. The steelwork will be completely erected on its own bearings in Glasgow, and subsequently dismantled and shipped in sections to East Africa. The estimated cost of this bridge is £80,000.

According to South African papers just to hand, an extraordinary meeting of the South African Manganese Company was held recently to consider a resolution for increasing the capital of the company to £35,000 by the creation of 140,000 new shares of 2s. 6d. each. It is understood that the funds will be devoted to a thorough testing of the company's farms. If the results are satisfactory to the new interests concerned, a big flotation will ensue to provide the funds necessary not only for exploitation, but also for participating in the use of the new manganese branch railway line.

Negotiations are nearing completion whereby Messrs. Ruston & Hornsby, Limited, of Lincoln, will join with the Bucyrus-Erie Company, of South Milwaukee, U.S.A., in the formation of a new company, to be known as Ruston-Bucyrus, Limited, with works and head offices at Lincoln, to specialise in the manufacture of excavating machinery. Both the parent firms are recognised as leading makers of excavating machinery. The contribution of Ruston & Hornsby, Limited, to Ruston-Bucyrus, Limited, will be their excavator business, including the whole of the excavator works and organisation. The Bucyrus-Erie Company will contribute an equivalent value in cash, and will transfer to the new company the whole of their interests in countries outside North and South America, Japan and China. Provision has been made for the maintenance of equality of capital holding and directorate representation of the respective companies. The first directors of the new company will be Col. Joseph S. Ruston, Messrs. G. R. Sharpley, J. H. W. Pawlyn and V. W. Bone, Lieut.-Col. P. D. Ionides, Sir Archibald Ross, and Messrs. R. W. Newberry and W. W. Coleman. Mr. Coleman, who is president and chairman of the board of the Bucyrus-Erie Company, will be chairman of the board, Col. Ruston will be vice-chairman and Mr. Victor Bone will be managing director. According to present plans, the new company will commence operations on January 1, 1930.

Company News.

Mond Nickel Company, Limited.—An extraordinary general meeting of the Mond Nickel Company, Limited, was held in London on September 23. Mr. D. Owen Evans, who presided, said that most of those present were aware of the fact that an agreement had been entered into between the Mond Nickel Company, Limited, and the International Nickel Company of Canada, Limited, to transfer the Mond Company's properties in Canada. Resolutions ratifying and confirming the agreement for the sale of the assets referred to, and further resolutions approving the scheme for the reorganisation of capital, were put to the meeting and carried unanimously.

Thos. W. Ward, Limited.—Mr. Joseph Ward, J.P. (the chairman), presided at the annual meeting of Messrs. Thos. W. Ward, Limited, held recently in Sheffield. In moving the adoption of the report and balance-sheet, he said that the twelve months had been a period of increased trade and marked advances in many directions. An important purchase during the year was that of the Lowmoor Ironworks, Bradford. The blast-furnace side of the works had been sold; the tar macadam plant with the slag heap were being worked. The forge for the manufacture of best Yorkshire iron had been retained in active operation. The directors thought it would be a calamity if these works were permanently closed down, and the world deprived of the use of such brands of Yorkshire iron as were produced there. A coal depôt was also being reconstructed at Lowmoor, and the business continued. There had been other important works dismantling purchases, and a large number of operations had taken place during the year, including Newburn Steelworks, High Yard, a portion of which had been sold and was working; Northumberland Forge, Erewash Furnaces, Rosedale Railway branch line, Rainford Colliery, Norfa Copper Works, and the recent purchase of the Yorkshire Iron & Coal Company. Their shipbreaking operations during the year represented the purchase of 45 vessels, amounting to 58,814 tons. This department had again suffered severely from foreign competition, and it had only been with difficulty that their ship-dismantling works had been kept partially going. On the other hand, their general scrap business had been exceptionally heavy. The suggested prohibition of exports of scrap from the United Kingdom would be a very serious handicap on the company's business. The value of good heavy steel scrap was equal to that of hematite iron, and rarely exceeded it. The exportation of steel scrap was only brought about when consumers at home for economic reasons offered less than its normal value, and the consumers abroad were prepared to pay its full normal value compared with that of basic and hematite pig-iron. The solution of these difficulties, in his opinion, was largely linked up with the retaining of all British obsolete tonnage for dismantling in this country, and the consumer paying the full normal value for scrap produced from such vessels.

Personal.

Sir Hugo Hirst has been re-elected Master of the Worshipful Company of Glaziers.

Mr. Charles F. Spencer has been elected a director of Messrs. John Brown & Company, Limited.

Mr. F. L. Bishop, F.R.G.S., managing director of Messrs. Thomas & Bishop, Limited, has been elected Master of the Worshipful Company of Plumbers.

An interesting ceremony recently took place in the offices of Messrs. Smith & Wellstood, Limited, Bonnybridge, during working hours, when Mr. Marshall, a much-esteemed and universally-loved member of the board of directors, was made the recipient of a handsome gift on the occasion of his retirai from the board. Mr. Marshall has taken a very active part in the administration of the business for 55 years, and the gift, which took the form of a wallet of Treasury notes, was subscribed by the staff, employees and directors as a token of the esteem in which he was held by all. Mr. R. Bell, staff manager, presided, and gave an appreciative speech, after which Mr. A. Mitchell, secretary, made the presentation. Mr. Marshall, in replying, referred to his long association with the firm, and expressed his sincere thanks for the kindness of all concerned.

Wills.

Boulton, A., brassfounder, of 199, Bridge Street, Birkenhead £1,584

Brooke, R. G., managing director of Messrs. Holden & Brooke, Limited, Manchester £60,379

Baxter, J. W., a director of Messrs. Latch & Batchelor, Limited, wire-rope manufacturers, Hay Mills, Birmingham £20,633

Atkins, G. F., Handsworth, a director of Bulpitt & Sons, Limited, aluminium hollow-ware manufacturers, of Birmingham £9,155

Applications for Trade Marks.

The following list of applications to register trade marks is extracted from the "Trade Marks Journal":—

"Searcher."—Steel. Hall & Pickles, Limited, Bessemer Road, Attercliffe, Sheffield.

"Pyrista."—Steel. English Steel Corporation, Limited, River Don Works, Brightside Lane, Sheffield.

"Tensola."—Rough metal castings. F. H. Lewis & Company, Union Foundry, Horseley Fields, Wolverhampton.

"Oxydalum."—Goods made of aluminium or aluminium alloys. Townshends, Limited, Ernest Street, Birmingham.

"Chromium."—Finished cast-metal goods. The Midland Motor Cylinder Company, Limited, Dartmouth Road Foundries, Smethwick.

"Bronzoy."—Bronze rods for use in welding. Alloy Welding Processes, Limited, Ferry Lane Works, Forest Road, London, E.17.

"Brunol."—Materials for the making of cores for casting metals. The Fordath Engineering Company, Limited, Albion Street, West Bromwich.

Reports and Dividends.

Babcock & Wilcox, Limited.—Interim dividend of 7 per cent. on the ordinary shares, tax free.

Vulcan Foundry, Limited.—Net profit, £94,025; brought in, £101,716; to reserve for depreciation of investments, £4,200; dividend of 10 per cent. on the ordinary shares; carried forward, £105,914.

Obituary.

Mr. Thomas Pearson Harris, a member of the firm of Harris & Pearson, firebrick manufacturers, of Stourbridge, has died at the age of 70 years. Mr. Pearson was also managing director of the Wellingborough Iron Company, Limited, and governing director of Messrs. Harris Brothers (Brierley Hill), Limited. He was a member of the Birmingham Exchange.

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WHO IS RESPONSIBLE?

LET US EXAMINE THE POSITION.

(1) If the value of this country's imports is greater than the value of its exports it has to send gold to make up the balance.

(2) This withdrawal of gold reduces the stock at the Bank of England, and this is held to jeopardise the country's financial stability.

(3) In order to discourage the people who borrow money and send it abroad (directly or indirectly) the rate of interest charged is thereupon increased by the Bank, as a result of which every depressed and struggling industry in the country has to pay another one per cent. on its overdraft.

(4) This is still another nail in the coffin of Britain's commerce—BUT

WHO DROVE THIS ONE IN?

(5) The answer is "Those who make needless foreign purchases either of goods or investments."

F.B.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Conditions in the Cleveland iron market continue fairly satisfactory, home consumptive demand having disclosed a steadily sustained increase, which at the moment almost precludes the execution of orders for prompt delivery beyond a limited tonnage, most of the makers' order books being well filled over the remainder of the year. Outputs of pig-iron at Tees-side furnaces, meanwhile, remain practically stationary, with only a faint prospect of early expansion, for reasons previously discussed connected with fuel scarcity difficulties. Thus there are still strict limits to the possibilities of an increase in the number of operative blast furnaces, and supplies of pig-iron may scarcely be sufficient for all industrial needs. The recent advance, notified in last week's reports, in the prices quoted by Midland furnaces, has not been followed by the Cleveland makers, but that must not be accepted as an admission that the local ironmasters are content with current prices, which, as a matter of fact, do not cover costs of production. But the makers have learnt by experience the dangers of inflation, and apparently they are hoping for a fall in the cost of raw material which will enable them to bridge the gap between costs and selling prices. In the meantime substantial home and moderately satisfactory foreign sales are reported at the old fixed prices, namely:—No. 1 Cleveland foundry iron, 75s.; No. 3 G.M.B., 72s. 6d.; No. 4 foundry iron, 71s. 6d.; No. 4 forge iron, 71s. per ton.

Some contraction in the Tees export trade for September has to be recorded. Coastwise shipments of pig-iron were 8,511 tons, and foreign shipments 10,349 tons, a total of 18,860 tons, compared with 24,548 tons in August.

An improved demand may also be noted in the case of East Coast hematite, the market having developed a more active demand, stimulated, doubtless, by apprehension of an advance in prices. Thus, while it is still possible to buy mixed numbers at 76s. 6d. and No. 1 quality at 77s. per ton, these figures are so far below the cost of production that some of the makers refuse to accept them, and prefer to put their pig-iron into stock. On the North-West Coast, the quotation for Bessemer mixed numbers remains at 77s. per ton, at works.

LANCASHIRE.—Business in the principal local markets for foundry pig has slowed down to some extent consequent upon the higher rates now demanded by the chief Midland furnaces, but specifications for deliveries on this month's account are regarded as fairly satisfactory. Quotations now stand as follow:—No. 3 Staffordshire, 77s.; No. 3 Derbyshire, 77s.; with Scotch brands at 92s. 6d. to 93s. 6d., all per ton, delivered local stations.

THE MIDLANDS.—From all accounts, the foundry industry in this area is now better employed than recently reported, and the demand for pig-iron has not been seriously affected by the recent advance in quotations, which now rule as follow:—No. 3 Northants, 75s.; No. 3 Derbyshire, 78s. 6d.; No. 3 North Staffordshire, 79s. 6d., all per ton, delivered local stations.

SCOTLAND.—No improvement can be reported in the state of the Scotch pig-iron trade. This is a disappointment, as traders were looking for a seasonal demand to materialise at this period, but there are still no signs of this improvement. The makers maintain the minimum price of 76s. for No. 3 Scotch foundry, f.o.t. furnaces.

Finished Iron.

In the manufacturing departments business offering is still restricted in volume, and in the Black Country the only bright feature of the market is the continued steady call for Staffordshire marked bars, the price of which has been raised to £12 10s., at works. There is a paucity of orders for crown bars at the present moment, and none of the mills is occupied regularly. The price of crown iron varies according to the district, and quotations are from £9 15s. to £10 5s. The position affecting nut and bolt bars is even worse than for crown iron, as the bulk of the orders for this class of bar is going to to the Continental makers, whose prices are nearly £2 10s. below the lowest local nut and bolt iron quotation.

Steel.

Recent movements in the chief home markets for semi-products, indicating increasing competition by Continental makers, have had an adverse effect upon business in general, and new specifications are difficult to negotiate. At Sheffield, the steel makers have decided to make no alteration in quotations at present in view of the cuts made in foreign prices recently. Basic billet business continues fairly good, but no improvement can be recorded in acid qualities. Quotations:—Basic billets, soft, £6 17s. 6d.; hard, £7 12s. 6d. to £9 12s. 6d.; Siemens acid billets, £9 10s.; soft basic steel hoops, £8 2s. 6d.; wire rods, soft basic, £8 10s.; hard basic, £10 15s.; acid, £12 5s. to £12 10s. The tinplate market continues active, with quotations firmly held at 18s. 9d. to 19s. basis for coke quality, net cash, f.o.b., Welsh ports.

Scrap.

Although deliveries of foundry scrap metals are still fairly up to the average, business in the principal markets is by no means brisk, with prices somewhat irregular. In Scotland best machinery cast-iron scrap now realises 70s., with ordinary at 65s., light descriptions at 62s. 6d. and old railway chairs at 67s. 6d. to 68s., all per ton delivered local works. On Tees-side, ordinary qualities of heavy cast iron, on the other hand, are rather easier, and 66s. 6d. per ton is now a full price, although machinery quality in handy pieces still realises about 68s. 6d. per ton. In the Midlands, there is a fairly good demand for heavy cast-iron scrap for use in the local foundries; 72s. 6d. delivered is asked for machinery scrap in cupola sizes, 65s. for heavy cast iron and 60s. for light cast iron.

Metals.

Copper.—Business in the markets for base metals during the current week has developed an irregular tone consequent upon the reported slowing down in American consumptive demand, while recent events in the City's financial world have also contributed in a measure as a disturbing factor in the position. This state of affairs, however, is not altogether surpising when it is remembered that, relatively speaking, the price of copper has been high, and with consumers generally well covered for their future needs, the natural outcome can only be a lull in the consumptive demand.

Closing quotations are:—

Cash.—Thursday, £73 13s. 9d. to £73 16s. 3d.; Friday, £73 16s. 3d. to £73 17s. 6d.; Monday, £74 2s. 6d. to £74 3s. 9d.; Tuesday, £74 13s. 9d. to £74 15s.; Wednesday, £74 8s. 9d. to £74 10s.

Three Months.—Thursday, £74 8s. 9d. to £74 10s.; Friday, £74 7s. 6d. to £74 8s. 9d.; Monday, £74 13s. 9d. to £74 15s.; Tuesday, £75 1s. 3d. to £75 2s. 6d.; Wednesday, £74 15s. to £74 17s. 6d.

Tin.—Nothwithstanding the more favourable features of the monthly statistics recently issued, values of standard tin met with a heavy reverse last week, and although recovering later, closed at about £5 lower on Friday. Nevertheless, it would appear that the depression has been overdone, and as American stocks are depleted, early buying will be necessary if heavy consumption is to be maintained on that side.

Official closing prices:—

Cash.—Thursday, £198 17s. 6d. to £199; Friday, £198 10s. to £198 12s. 6d.; Monday, £198 12s. 6d. to £198 15s.; Tuesday, £196 10s. to £196 15s.; Wednesday, £196 10s. to £196 12s. 6d.

Three Months. — Thursday, £202 15s. to £202 17s. 6d.; Friday, £202 5s. to £202 7s. 6d.; Monday, £202 10s. to £202 12s. 6d.; Tuesday, £200 10s. to £200 12s. 6d.; Wednesday, £200 10s. to £200 12s. 6d.

Spelter.—Despite a slight improvement in the consumptive demand, occasioned to a certain extent by the lower level of values now obtaining, prices have recently continued on the down grade as the result of further general selling and liquidation.

Daily quotations are:—

Ordinary.—Thursday, £23 17s. 6d.; Friday, £23 17s. 6d.; Monday, £23 16s. 3d.; Tuesday, £23 15s.; Wednesday, £23 12s. 6d.

Lead.—Quiet but active conditions continue to rule in the lead market, although American advices report great activity of late in that country. With producers willing to meet all demands at the present level of values, it is improbable that there will be any rise in the near future other than small fluctuations from day to day.

The week's prices have been:—

Soft Foreign (Prompt).—Thursday, £23 12s. 6d.; Friday, £23 12s. 6d.; Monday, £23 12s. 6d.; Tuesday, £23 12s. 6d.; Wednesday, £23 5s.

Students' Corner.

Q.—What are we to understand by liquid expansion and contraction?

A.—Above the fusion temperature there will be to some extent a corresponding expansion in the molten mass according to the temperature reached. Now, if that be true, it will be obvious that the higher the temperature of the molten iron when a mould is poured, the greater will the liquid shrinkage be.

Q.—Is the fusion temperature the same in all grades of cast iron?

A.—No. A refined cast iron will have a higher melting point, a higher freezing point, and a narrow range of fluidity than the ordinary grades of cast iron.

Q.—What is a refined cast iron that it will differ from ordinary grades of iron?

A.—The difference is that it contains less carbon less silicon and less phosphorus. When these three constituents are low the melting and freezing points are raised. There are also variations in other grades of ordinary cast iron, but to a less extent; for instance, white iron has a lower melting point and freezing point than grey iron. The purer the iron the higher the melting and freezing temperatures, also the range of fluidity is narrow, *i.e.*, it will not remain in the fluid state as long as the ordinary grades of cast iron.

Q.—Do all heavy castings require feeding?

A.—It depends primarily upon the design of the casting. The total weight of a casting is no indication regarding whether that casting requires feeding or not. It is quite possible that a casting weighing 20 tons may require no feeding, and a casting weighing a few pounds may require feeding, drawn places and shrinkage holes will occur in very light castings as well as in very heavy castings. A casting of any weight may be so evenly and well proportioned in design that no shrink or draw holes will occur, therefore feeding by rod or head is necessary. The primary cause of expansion above the melting point is the same as that below the freezing point, namely, absorption of heat by the metal, and the expansion is according to the amount of heat absorbed, consequently the cause of liquid contraction is evolution, or loss of heat, that is the simplest way I can put it.

With such a complex mixture as cast iron is, containing as it does in varying percentages of carbon, phosphorus, silicon, sulphur, manganese, and possibly other elements, between the melting point and the higher temperatures, say, up to 1,500 deg. C. and again from that temperature down to freezing, many separations and molecular changes may take place, of which certain or exact knowledge is very limited. The major concern is that liquid iron in bulk does contract when cooling, leaving hollow and unsound places, of which the foundryman must find ways and means of making good and sound.

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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	74	8	9
Three months	74	15	0
Electrolytic	84	5	0
Tough	78	5	0
Best selected	78	15	0
Sheets	110	0	0
India	94	10	0
Wire bars	84	12	6
Do. Oct.	84	12	6
Do. Nov.	84	12	6
Ingot bars	—		
H.C. wire rods	86	12	6
Off. av. cash, September	75	6	9 1/16
Do. 3 mths., September	75	19	4 1/2
Do., Sttlmnt., September	75	7	1 1/2
Do., Electro, September	84	12	9 1/2
Do., B.S., September	79	18	1 1/2
Do. wire bars, September	84	18	4
Aver. spot price, copper, Sept.	75	6	9 1/16
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11 1/4d.

BRASS.

Solid drawn tubes	12 1/2d.
Brazed tubes	14 1/2d.
Rods, drawn	12 1/2d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	11 1/2d.
Wire	11 1/2d.
Rolled metal	10 7/8d.
Yellow metal rods	8d.
Do. 4 × 4 Squares	8 1/2d.
Do. 4 × 3 Sheets	9d.

TIN.

	£	s.	d.
Standard cash	196	10	0
Three months	200	10	0
English	196	15	0
Bars	198	15	0
Straits	201	0	0
Australian	199	0	0
Eastern	203	10	0
Banca	204	10	0
Off. av. cash, September	204	18	9
Do., 3 mths., September	208	17	8
Do., Sttlmt., September	204	18	5 1/2
Aver. spot, September	204	18	9

SPELTER.

	£	s.	d.
Ordinary	23	12	6
Remelted	22	5	0
Hard	20	5	0
Electro 99.9	25	15	0
English	24	2	6
India	21	5	0
Zinc dust (Nom.)	34	10	0
Zinc ashes	8	0	0
Off. aver., September	24	8	11 1/2
Aver., spot, September	24	4	2

LEAD.

	£	s.	d.
Soft foreign ppt.	23	5	0
English	24	15	0
Off. average, September	23	11	5 1/2
Average spot, September	23	11	1 1/2

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	32	15	0
Do. V.M. ex-whf.	31	12	6
Rods	38	0	0
Boiler plates	29	10	0
Battery plates	30	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	50	0	0
Chinese	31	0	0
Crude	Nominal		

QUICKSILVER.

	£	s.	d.
Quicksilver	22	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	15	0
45/50%	11	15	0
75%	19	0	0
Ferro-vanadium—			
35/50%	12/10 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/- lb. Mo.		
Ferro-titanium—			
23/25% carbonless	1/1 lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%, c. fr.	3/3 1/2 lb.		
Tungsten metal powder—			
98/99%	3/6 1/2 lb.		
Ferro-chrome—			
2/4% car.	£31	0	0
4/6% car.	£23	0	0
6/8% car.	£21	17	6
8/10% car.	£21	10	0
Ferro-chrome—			
Max. 2% car.	£33	0	0
Max. 1% car.	£38	0	0
Max. 0.70% car.	£40	0	0
70%, carbonless	1/- lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/4 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/6 lb.		
Ferro-manganese (net)—			
76/80% loose	£13	10	0
76/80% packed	£14	10	0
76/80%, export	£14	0	0
Metallic manganese—			
94/96%, carbonless	1/6 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finshed bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under 1/8 in. to 1/4 in.	3d. lb.
Do., under 1/4 in. to 1/16 in.	1/- lb.
Flats, 1/8 in. × 1/4 in. to under 1 in. × 1/8 in.	3d. lb.
Do., under 1/8 in. × 1/4 in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel					3	15	0
Bundled steel and shrngs.	3	10	0	to	3	14	0
Mixed iron and steel	3	7	6	to	3	10	0
Heavy cast iron	2	17	6	to	2	19	0
Good machinery for foundries	3	0	0	to	3	2	6
Cleveland—							
Heavy steel					3	6	6
Steel turnings					2	16	6
Cast iron borings					2	14	0
Heavy forge					3	17	6
W.I. piling scrap					3	10	0
Cast-iron scrap	3	6	0	to	3	8	6
Lancashire—							
Cast-iron scrap	3	2	6	to	3	10	0
Hvy. wrought					4	0	0
Steel turnings					2	17	6
Scotland—							
Heavy steel					3	15	0
Cast-iron borings					2	15	0
Wrought-iron piling					3	18	6
Heavy machinery					3	10	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	68	0	0
Brass	44	0	0
Lead (less usual draft)	21	5	0
Tea lead	17	0	0
Zinc	16	0	0
New aluminium cuttings	71	0	0
Braziery copper	59	0	0
Gunmetal	61	0	0
Hollow pewter	150	0	0
Shaped black pewter	106	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	77/-
Hematite M/Nos.	76/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
,, d/d Birm.	93/6
Midlands—	
Staffs. common*	—
,, No. 4 forge*	75/6
,, No. 3 fdry*	79/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	71/-
,, fdry. No. 3*	75/-
Derbyshire forge*	74/6
,, fdry. No. 3*	78/6
,, basic*	—

* d/d Black Country dist.

Scotland—	
Foundry No. 1	78/6
,, No. 3	76/-
Hem. M/Nos.	80/-
Sheffield (d/d district)—	
Derby forge	69/6
,, fdry. No. 3	73/6
Lincs. forge	73/-
,, fdry. No. 3	77/-
E.C. hematite	87/6
W.C. hematite	89/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	77/-
Northants foundry No. 3	—
Dalzell, No 3 (special)	102/6 to 105/-
Summerlee, No. 3	93/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	93/-
Monkland, No. 3	93/-
Shotts, No. 3	93/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom.					10	15	0
Nut and bolt iron	9	0	0	to	9	5	0
Hoops	11	0	0	to	11	10	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip	11	0	0	to	11	10	0
Bolts and nuts, 1/2 in. × 4 in.					15	5	0
Steel—							
Ship plates	8	12	6	to	8	17	6
Boiler plts.	9	12	6	to	10	10	0
Chequer plts.					10	12	6
Angles					8	2	6
Tees					9	2	6
Joists					8	2	6
Rounds and squares, 3 in. to 5 1/2 in.					9	2	6
Rounds under 3 in. to 1/2 in. (Untested)					8	5	0
					and upwards		
Flats, over 5 in. wide and up					8	7	6
Flats, 5 in. to 1 1/2 in.					8	2	6
Rails, heavy					8	10	0
Fishplates					12	10	0
Hoops (Staffs)					10	0	0
Black sheets, 24g.	10	5	0	to	10	10	0
Galv.cor.shts., 24g.	13	7	6	to	13	10	0
Galv. fencing wire 8g. plain					12	0	0
Billets, soft	6	5	0	to	6	15	0
Billets, hard	7	10	0	to	8	0	0
Sheet bars					6	5	0
Tin bars					6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6 1/2
Rods	1/5
Tubes	1/9 1/2
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4 1/2 to 1/10 1/2
To 15 in. wide	1/4 1/2 to 1/10 1/2
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5 1/2 to 1/11 1/2
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6 1/2
Ingots rolled to spoon size	1/1 to 1/9 1/2
Wire round—	
3/0 to 10 G.	1/7 1/2 to 2/2 1/2

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, No. 13	2.35
Wire nails	2.45
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	27/6
,, furnace	21/- to 22/-
Durham and North.	
,, foundry	22/6
,, furnace	21/-
Midlands, foundry	—
,, furnace	21/6 and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/9
,,	28×20 ,,	37/6
,,	20×10 ,,	27/6
,,	18 1/2×14 ,,	19/6
C.W.	20×14 ,,	15/6
,,	28×20 ,,	34/-
,,	20×10 ,,	22/7 1/2
,,	18 1/2×14 ,,	16/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ⅛ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65%	47½%
Water	61½%	42½%
Steam	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Oct.	3	73	13	9	dec.	1/3
,,	4	73	16	3	inc.	2/6
,,	7	74	2	6	,,	6/3
,,	8	74	13	9	,,	11/3
,,	9	74	8	9	dec.	5/-

Electrolytic Copper.

		£	s.	d.					
Oct.	3	84	5	0	inc.	5/-	Oct.	3	
,,	4	84	5	0	No	change	,,	4	
,,	7	84	5	0	,,	,,	,,	7	
,,	8	84	5	0	,,	,,	,,	8	
,,	9	84	5	0	,,	,,	,,	9	

Standard Tin (cash).

		£	s.	d.					
Oct.	3	198	17	6	inc.	55/-	Oct.	3	
,,	4	198	10	0	dec.	7/6	,,	4	
,,	7	198	12	6	inc.	2/6	,,	7	
,,	8	196	10	0	dec.	42/6	,,	8	
,,	9	196	10	0	No	change	,,	9	

Tin (English ingots).

		£	s.	d.					
Oct.	3	199	0	0	inc.	50/-	Oct.	3	
4		198	10	0	dec.	10/-	,,	4	
7		198	15	0	inc.	5/-	,,	7	
8		196	15	0	dec.	40/-	,,	8	
9		196	15	0	No	change	,,	9	

Zinc Sheets (English).

		£	s.	d.					
Oct.	3	32	15	0	No	change	Oct.	3	
,,	4	32	15	0	,,	,,	,,	4	
,,	7	32	15	0	,,	,,	,,	7	
,,	8	32	15	0	,,	,,	,,	8	
,,	9	32	15	0	,,	,,	,,	9	

Spelter (ordinary).

		£	s.	d.		
Oct.	3	23	17	6	inc.	3/9
4		23	17	6	No	change
7		23	16	3	dec.	1/3
8		23	15	0	,,	1/3
9		23	12	6	,,	2/6

Lead (English).

		£	s.	d.		
Oct.	3	24	15	0	No	change
4		24	15	0	,,	,,
7		24	15	0	,,	,,
8		24	15	0	,,	,,
9		24	15	0	,,	,,

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	4 15 0	4 17 6	5 0 0	5 0 0	5 0 0	4 17 6	4 17 6	4 17 6	4 17 6	5 0 0	5 7 6	5 7 6	4 19 9½
1897	5 7 6	5 7 6	5 7 6	5 5 0	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 2 6	5 0 0	5 5 0	5 3 5½
1898	5 5 0	5 5 0	5 5 0	5 7 6	5 13 9	5 15 0	5 15 0	5 15 0	5 17 6	6 0 0	6 5 0	6 7 6	5 14 3
1899	6 10 0	6 12 6	6 15 0	6 15 0	6 17 6	6 17 6	7 0 0	7 0 0	7 5 0	7 5 0	7 12 6	7 15 0	7 0 5
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 10 0	7 10 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 6
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 12 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6½
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	10 0 0	10 0 0	10 0 0	9 8 9	9 9 6	9 10 0	9 8 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	7 8 5½	7 9 0	7 12 6	7 16 3	8 0 6	7 7 7
1927	7 18 9	7 17 6	7 17 6	7 14 8½	7 13 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 16 10½
1929	7 17 6	7 17 6	7 17 6	7 17 6	8 0 6	8 2 6	8 2 6	8 2 6	8 2 6	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

PRACTICAL FOUNDRYMAN desires re-engagement as Foreman, iron or non-ferrous.—Box 350, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Charge-hand Foreman for Steel Foundry near London district; must be used to small castings; good prospects.—State experience, wages, etc., to Box 344, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Young Man with Engineering and preferably Light Casting experience who has studied "Taylor's" methods, to investigate existing processes on behalf of works director; good opportunity.—Write, stating full experience and training, age, and salary required, also whether in employment, to Box 342, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WORKING Machine Moulder Charge-hand for Cast Iron Foundry wanted; used to Bonvillain Hydraulic and Pneumatic Squeese Moulding Machines; must be able to keep up output and get results from labour; mechanics attend machines and modern sand-handling plant.—Write fully, stating experience, wages required, age, and whether in employment, to Box 338, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

AGENCIES.

A PRACTICAL FOUNDRYMAN with large connection among London engineers desires to represent an iron foundry near London on commission basis only. Foundries applying must be in a position to quote competitive prices and prompt delivery.—Apply, Box 348, Offices of The Foundry Trade Journal, 49, Wellington, Street, Strand, London, W.C.2.

A FIRM of Bronze and Iron Founders specialising in Architectural and Decorative Castings desires to appoint agent on commission basis; one with a good connection amongst users of fine-faced castings up to 30 cwts.—Box 340, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY.

11 ACRES WORKS SITE.
SHEFFIELD.
145,000 Sq. Ft. of SHOPPING,
Compact and Convenient.
SIDING CONNECTIONS
with L.M. & S. and L. & N.E. Rlys.
WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

BARGAIN IN TRAFFORD PARK.—Engineering Works and Foundry; private sidings, warehouse, packing rooms; fine offices; central heating; all on one storey and easily adaptable; cost £20,000 in 1921—price £2,000, including two 4-ft. Modern Cupolas and Steel Chimney.—F. S. Airey, Entwistle & Company, 10, Norfolk Street, Manchester.

ROPERTY—*Continued.*

DERBYSHIRE IRON FOUNDRY TO LET, whole or part, suitable for Brass or Malleable Works.—Box 346, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.

WANTED, Cupola Hoist, with or without Staging.—Box 334, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

'PHONE **98** STAINES.

120/140-h.p. Tangye Semi-Diesel CRUDE OIL ENGINE.

40-kw. Semi-Diesel Crude Oil Generating Set, 220/440 volts D.C.

Unused 35-b.h.p. Bates Semi-Diesel Crude Oil Engine in maker's cases. Bargain.

HARRY H. GARDAM & CO., LIMITED, STAINES.

5-cwt. Green's CUPOLETTE, new, unused, £24.
1-ton Jackman CUPOLA, new, unused, £38.
2-ton Whiting (Jackman) CUPOLA, as new, £55.

A. Hammond, 14, Australia Road, Slough.

PRATT & WHITNEY Automatic Surface Grinder, for thread milling cutters.

UNGER 8-in. x 32-in. Universal Grinding Machine, with internal attachment.

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